

HUGO RIEMANN'S CONCEPT OF TONALITY

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A thesis submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Arts in the Department of Music.

Chapel Hill
2007

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ABSTRACT

TARA TACHOVSKY: Hugo Riemann's Concept of Tonality
(Under the direction of Felix Wörner)

This study examines the relationship between theories of harmonic dualism, Riemann's concept of undertones, and Riemann's theories of tonality in the context of nineteenth-century science. As one of the scholars who helped define the field of musicology, Riemann contributed to the impetus to legitimate the discipline by creating ties with other fields. In the first section, I trace the influence of Moritz Hauptmann, Hermann von Helmholtz, and Arthur von Oettingen on Riemann's work, with reference to how Riemann's theories of tonality were derived from the principles of harmonic dualism and his concept of undertones. In the final section, I look at Riemann's theories from the perspective of his critics and show how his ideas were reformulated through interaction with his contemporaries.

ACKNOWLEDGMENTS

I would especially like to thank my advisor, Felix Wörner, for his patient support and guidance. He remained committed to helping and encouraging me during every step of my work. I am also grateful to the other members of my committee, Mark Evan Bonds and Jon Finson, for taking time from their summer vacations to read and comment on this thesis. I owe a debt to the many teachers who nurtured my love of learning, to my professors and friends at Rice University who helped me find my way to musicology, and to my professors and colleagues at the University of North Carolina at Chapel Hill, who continue to inspire me. Most of all, I thank my parents for their unceasing love and support.

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I. INTRODUCTION

The nineteenth century was a century of science in Germany.¹ During this time, the scientific fields assumed their modern meaning and scope as they broke away from natural philosophy. There was a vast explosion of scientific knowledge, and new institutional and social structures developed to accommodate the growth of the modern disciplines of chemistry, physics, mathematics, biology, and the social sciences. Science influenced all “social and cultural spheres of life,” and the culture of the period understood itself as a scientific culture.² The new fields of medicine, technology, industry, and music came to embody scientific methods and emphasized systematic rigor. This growth in the institutionalization of new fields dedicated to science was accompanied by a general disillusionment with the philosophy of Absolute Idealism. As a result, science remained the only “unquestionable source of legitimacy.”³ In other words, the nineteenth century and science were synonymous with notions of progress.⁴

It is not surprising, therefore, that Hugo Riemann (1849–1919), one of the founding fathers of German musicology, sought justification for his theories in the current methods and ideals of the sciences. Riemann believed that music aesthetics and

¹ Herbert Schnädelbach, *Philosophy in Germany 1831–1933*, trans. Eric Matthews (Cambridge: Cambridge University Press, 1984). Unless noted, I use the term science to include not only the natural or physical sciences, but also the methods of the human sciences [*Geisteswissenschaften*], which encompass the humanities and social sciences.

² *Ibid.*, 30, 68.

³ *Ibid.*, 68.

⁴ Cahan, David, ed., *From Natural Philosophy to the Sciences: Writing the History of Nineteenth-Century Science* (Chicago: University of Chicago Press, 2003), 4.

analysis should be valued as much as the natural sciences. He wrote to Franz Liszt in 1879:

Music theory belongs among the natural sciences, at least as much as art is nature; music theory would have the right to exist even if it only fulfilled the single purpose of proving the immanent law-abiding order of artistic creation.⁵

Riemann was not alone in this endeavor to defend musical scholarship, and much of his work can be viewed as the fulfillment of Friedrich Chrysander's exhortation to raise the field to the level of a scientific discipline. In the foreword to the 1863 *Jahrbücher für musikalische Wissenschaft*, Chrysander defined his objective to carve a space for musicology as an independent scholarly discipline:

We use the word 'science' in the strictest and fullest sense; and we are publishing these yearbooks with the title 'for musical understanding' [*musikalische Wissenschaft*] to make it clear that it is the territory of science that we are entering, that we submit to the strictest claims of science and hope to serve her, according to our powers, on the widest possible scale. We intend to consider the whole field of music and to... [discuss] the whole field of music according to a single, scientific set of principles.⁶

In the "fullest sense," the term *Wissenschaft* (science, scholarship, knowledge) can describe any organized or systematic academic study, yet emphasizing the "strictest" sense, Chrysander identified the systematic nature of scientific scholarship and the

⁵ La Mara [Maria Lipsius], ed., *Briefe hervorragender Zeitgenossen an Franz Liszt*, vol. 3 (Leipzig: Breitkopf & Härtel, 1904), 341. "In diesem Sinne gehört die Musiktheorie unter die Naturwissenschaften, soweit nämlich die Kunst Natur ist; sie würde eine Existenzberechtigung haben, auch wenn sie nur den einen Zweck verfolgte, die immanente Gesetzmäßigkeit des künstlerischen Schaffens nachzuweisen." See also Hugo Riemann, "Der gegenwärtige Stand der musikalischen Aesthetik," in *Präludien und Studien: gesammelte Aufsätze zur Aesthetik, Theorie und Geschichte der Musik*, vol. 2 (Leipzig: H. Seemann Nachfolger, 1900–01), 46–55.

⁶ Friedrich Chrysander, "Vorwort und Einleitung," *Jahrbücher für musikalische Wissenschaft*, vol. 1 (Leipzig, 1863): 10. Translated by Martin Cooper in Bojan Bujic, ed., *Music in European thought 1851–1912* (Cambridge: Cambridge University Press, 1988), 346.

necessity to build knowledge from a “single, scientific set of principles.” For Chrysander, all components of the system must interact to serve a common objective.

Similarly, as a music theorist, Riemann sought to construct a system of general laws to explain all aspects of music. In his own words, “Time will decide whether my system is worthy or not; if it can be successfully demonstrated that the principle itself is false, then the entire system will fall apart like a house of cards.”⁷ The underlying principle that unites Riemann’s works is his belief in harmonic dualism and an undertone series to provide a natural basis for minor tonality.

In order to defend the merits of his theoretical system, Riemann drew freely on scientific, idealist, and historical methods to legitimize his work, furthering ties between music and physiology, psychology, and philosophy. He sought justification for his theories in the empirical observation of physical phenomena, and he also explored more subjective sciences that focus their study on the interior of the mind. While we can read Riemann’s effort to combine these diverse methods in terms of his endeavor to define musicology, he was not completely successful in integrating the opposing methodologies of the “empirical and phenomenal” against the “logical and deductive.”⁸ Scholars have pointed to this tension between empiricist and idealist thought that runs through Riemann’s writings.⁹

⁷ Hugo Riemann, “Die Lehre vom musikalischen Vortrag in der neusten Litteratur,” in *Präludien und Studien*, vol. 2 (Leipzig: H. Seemann Nachfolger, 1900–01), 173. Originally published in *Der Klavier-Lehrer* 9 (1886): 169–72, 182–85, 195–98, 208–11, 220, 232–34. “Den Wert oder Unwert meines Systems wird die Zeit entscheiden; gelingt es, das Prinzip selbst als falsch nachzuweisen, so fällt das Ganze zusammen wie ein Kartenhaus.”

⁸ Ruth A. Solie, review of *Hugo Riemann’s Theory of Harmony, with a Translation of Riemann’s History of Music Theory, Book III*, by William C. Mickelsen, *19th-Century Music* 2/2 (Nov. 1978): 181.

⁹ See Wilibald Gurlitt, “Hugo Riemann (1849–1919),” *Veröffentlichungen der Akademie der Wissenschaften und der Literatur, Mainz: Abhandlungen der geistes- und sozialwissenschaftlichen Klasse*

Riemann also drew on historicist viewpoints to establish his theoretical system. He constructed an historical narrative, with nineteenth-century harmony as the endpoint, and everything earlier as the undeveloped, primitive seeds from which later stages could grow and develop.¹⁰ In this way, Riemann interpreted Greek monody and Medieval chant as containing the seeds of harmony. In order to support his ideas on harmony as the foundation of music, he needed to identify a harmonic aspect as present in monophonic music. In his *Geschichte der Musiktheorie im IX.–XIX. Jahrhundert (History of Harmonic Theory)*, Riemann traced the development of harmonic theory. He approached the work of earlier theorists with the objective of supporting his own views on the primacy of harmony and tonal harmonic logic.¹¹ With his history of theory project, Riemann tried to map the origins of his own ideas about music theory and show how they developed and evolved naturally in order to legitimize his theories as applicable to all music. His methods paralleled those of the sciences, which view the history of science as developmental, ever striving to find a better way of describing the unchanging essence of nature.¹²

Because of Riemann's long career as a theorist and musicologist and his enormous body of published writings, it is difficult to unify his works. For this reason, I

Jg. 1950, No. 25 (Wiesbaden: Verlag der Akademie der Wissenschaften und der Literatur in Mainz, 1951); Peter Rummenh ller, *Musiktheoretisches Denken im 19. Jahrhundert* (Regensburg: Gustav Bosse, 1967); Rummenh ller, "Der fluktuierende Theoriebegriff Hugo Riemanns. Musiktheorie zwischen Idealismus und Naturwissenschaft," in *Hugo Riemann (1849–1919). Musikwissenschaftler mit Universalanspruch*, Tatjana B hme-Mehner and Klaus Mehner (K ln: B hlau, 2001), 31–36; Carl Dahlhaus, *Die Musiktheorie im 18. und 19. Jahrhundert*, Teil 1: *Grundz ge einer Systematik*, Bd. 10 in Frieder Zaminer ed., *Geschichte der Musiktheorie* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1984), 92–97.

¹⁰ Scott Burnham, "Method and Motivation in Hugo Riemann's History of Music Theory," *Music Theory Spectrum* 14 (1992): 2.

¹¹ *Ibid.*, 4.

¹² *Ibid.*, 11.

will concentrate on illuminating Riemann's concept of undertones, which, as I stated earlier, forms the foundation that holds together his system of tonality to describe major and minor scales, chords, cadences, and musical works. After an overview of theories of harmonic dualism, I will show how Riemann's concept of tonality evolved from the existing intellectual tradition and how he drew on various methodologies to justify and construct his dualistic theories. In addition to the conflict that arises from his reliance on competing methodologies, there is an inherent contradiction in Riemann's changing notion of undertones as observable and objective, or unobservable and subjective phenomena. In the final section, I will survey the reception of Riemann's theories to trace how this contradiction is apparent in the interactions between Riemann and his critics. Examining Riemann's concept of tonality and its basis in undertones from these two angles can help us understand Riemann's development and work as a whole, and in addition, it illuminates how shifting attitudes toward science and philosophy in the nineteenth century affected the emerging discipline of musicology.

II. THEORIES OF TONALITY

Because of the general prestige of science in nineteenth-century Germany, Riemann inherited a tradition of music theory that was based heavily in the experimental and empirical methods of natural science. The main figures in the field of musical perception, including Hermann von Helmholtz, Arthur von Oettingen, and Carl Stumpf, worked primarily as scientists, and they approached musical questions from a scientific perspective. Their work in the physics and acoustics of music, the physiology of hearing, and the psychology of perception established the scientific tone for the discipline in the second half of the nineteenth century. Investigation into consonance, dissonance, and harmony was based increasingly on acoustics and calculations involving combination tones, beats, and difference tones, rather than with reference to the canonic of the medieval tradition.¹³ Influenced by the work of Helmholtz, Oettingen, and Stumpf, Riemann picked up on the major developments in these fields during the early part of his career in the 1870s and integrated their results in his work. In order to understand the development of Hugo Riemann's theories concerning tonality, we must first place them within the context of nineteenth-century music theory, and more specifically examine the development of harmonic dualism.

¹³ Burdette Green and David Butler, "From acoustics to *Tonpsychologie*," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 246.

Harmonic Dualism

Music theorists since Zarlino have struggled to explain the minor mode. Zarlino established a tradition of classifying the major triad as a more perfect consonance than the minor triad. He justified his preference using Pythagorean mathematics and the fact that if string lengths represented the notes of a major triad, the middle term is the harmonic mean of the fifth, which he viewed as the natural mathematical progression. In contrast, the minor third resembled the arithmetic mean, which Zarlino considered to be contrary to nature. He classified the minor triad as less perfect harmony, because unlike in the major triad, the elements are not arranged in their “natural” locations.¹⁴

Following this tradition, René Descartes, in his *Compendium of Music* (ca. 1618), defined the major third as a primary consonance (4/5) because it could be generated directly by the division of the octave, whereas he considered the minor third to be a mere “shadow” of the major third because it had no basis in nature.”¹⁵ The minor third in a major triad could only be *indirectly* derived from the major third. For Zarlino, the bottom interval of the major triad was of greater importance, and the minor third above it was merely the “residue” that filled in the space between the major third and the fifth in a major triad.¹⁶

In *Die Natur der Harmonik und Metrik* from 1853, Moritz Hauptmann reacted against the movement to define music purely in terms of acoustics and natural science. Instead, Hauptmann favored a return to the more speculative traditions of Hegelian

¹⁴ See Dale Jorgensen, “A Résumé of Harmonic Dualism,” *Music & Letters* 44/1 (Jan. 1963): 32–33.

¹⁵ René Descartes, *Compendium of Music*, trans. Walter Robert, *Musicological Studies and Documents* 8 ([Rome?]: American Institute of Musicology, 1961), 21–27; Joel Lester, “Rameau and eighteenth-century harmonic theory,” in Christensen, *The Cambridge History of Western Music Theory*, 759.

¹⁶ Descartes, *Compendium of Music*, 26.

Hauptmann defined the minor triad as *being* of a “passive nature,” whereas the major triad was “active” in nature and *had* “upward driving weight.”¹⁹ He associated *having* [*haben*] with an active state, and *being* [*sein*] with a passive state. Because it is the fifth of the minor chord that determines the root and the third, the positive unity of the root is *determined*, whereas in the major chord, it is the root, which *does the determining* of the other two notes.²⁰

Although Hauptmann claimed to have left behind complete reliance on “acoustical presuppositions” to determine his theory,²¹ their influence remains visible behind the veil of dialectics that he attached to his ideas.²² If Hauptmann defined the minor triad in opposition to the major triad, he still placed emphasis on the major third as the determining interval. In addition, his derivation of the octave, fifth, and major third as the primary intervals and functions is based on string ratios and their placement in the overtone series as the first, second, and third partials. Hauptmann, though he perpetuated the idea that minor was more “passive” compared to major, had a large influence on later theories of harmonic dualism.

In contrast to Hauptmann’s view of tonality as based in Hegelian dialectics, Helmholtz approached music as something that could be measured using the methods of the natural sciences. Semlar Bagge, editor of the *Allgemeine musikalische Zeitung*, characterized Hauptmann and Helmholtz as the representatives of competing movements

¹⁹ Hauptmann, *The Nature of Harmony and Metre*, 16.

²⁰ *Ibid.*, 14–17.

²¹ *Ibid.*, xxxviii.

²² See Daniel Harrison, *Harmonic Function in Chromatic Music*. (Chicago and London: University of Chicago Press, 1994), 222. Harrison notes that Hauptmann’s musical system was in place before he added the “philosophical casing” to justify them.

in the search for a scientific basis of musical laws: Hauptmann argued from a musician's perspective, and Helmholtz from the viewpoint of a physicist.²³ In *Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik* (1863), Helmholtz put forward a new argument challenging the natural basis of the minor triad. Helmholtz, an eminent physicist and physiologist, concluded that minor harmonies were corrupted forms of major, and were “obscurely harmonious,” “ambiguous,” and acoustically impure.²⁴ In addition to appealing to the traditional argument against a natural basis of minor that stressed either *canonics* or the relationship of a fundamental to its partial tones, Helmholtz based his theories on acoustics and physical measurements within the framework of controlled experimentation. Helmholtz invested his work with almost unprecedented scientific rigor, and while many musicians objected to his conclusions, his empirical evidence against minor harmonies was, at least in terms of physics, essentially incontrovertible.

Helmholtz used the concept of “beats” [*Schwebungen*] to explain consonance and dissonance:

When two musical tones are sounded at the same time, their united sound is generally disturbed by the beats of the upper partials, so that a greater or lesser part of the whole mass of sound is broken up into pulses of tone [*Tonstösse*], and the joint effect is rough. This relation is called *Dissonance*.²⁵

²³ Selmar Bagge, “Zur Theorie der Musik. Der Physiker und die Musiker,” *Leipziger Allgemeine Musikalische Zeitung* 2, no. 21 (1867): 165–69.

²⁴ Hermann von Helmholtz, *On the Sensations of Tone*, trans. Alexander J. Ellis (London, 1885; repr., New York: Dover, 1954), 299–300. Originally published as *Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik* (Brunswick, 1863).

²⁵ *Ibid.*, 194.

In contrast, consonance occurs when few or no beats are produced. Helmholtz also used the concept of beats to justify our aesthetic preference for major harmony over minor at the ends of pieces because a major triad gives a fuller sense of closure. Helmholtz explained that although major and minor triads should theoretically produce a similar number of beats because they contain identical intervals, in actuality, the minor triad produces more beats because of the extra beats that are formed as a result of combination tones.²⁶ In general, because the minor third was not an immediate partial tone generated from a fundamental, it was therefore not as natural as the major third.²⁷

Theorists who sought to justify the aesthetic value of the minor mode were forced to contend with the established work that judged major as closer to nature than minor. They had always appealed to nature to impose order on their systems and to give them the authority to generate seemingly incontestable laws,²⁸ but in the context of the nineteenth-century scientific culture, it became even more important for music theorists to anchor their theories in an external reference point. Helmholtz's evidence and his eminence as a scientist made it more difficult for his opponents to challenge his ideas.

Harmonic dualist theories developed in response to this problem. Harmonic dualism can be defined as “the attempt to declare the major and minor modes as natural, in conflict with the scientifically accepted concept of nature at the time.”²⁹ Harmonic

²⁶ Helmholtz, *On the Sensations of Tone*, 214–15. Whereas beats can be measured as changes in the intensity level of a sound vibration, combination tones were conceived as an entirely subjective phenomenon based in the perception of the listener. See Green and Butler, “From acoustics to *Tonpsychologie*,” 254–56.

²⁷ Helmholtz, *On the Sensations of Tone*, 294.

²⁸ Suzannah Clark and Alexander Rehding, eds. *Music Theory and Natural Order from the Renaissance to the Early Twentieth Century* (Cambridge: Cambridge University Press, 2001), 2.

²⁹ Rehding, *Hugo Riemann and the Birth of Modern Musical Thought*, 31.

dualism explains the minor triad as the equal and opposite image of the major triad: both the major and minor triads contain a perfect fifth and major third, but whereas the major triad is built upwards from bottom to top (M3 + P5), the minor triad is built from top to bottom (M3 + P5).

In 1866, Arthur von Oettingen, who was known primarily as a physicist, incorporated Hauptmann's and Helmholtz's ideals in his *Harmoniesystem in dualer Entwicklung* (System of harmony in dual development). Oettingen reconciled the two approaches to claim a scientific basis for harmony without giving up its musical and philosophical essence.³⁰ Oettingen argued for the equality of major and minor using evidence based on empirical observation and acoustics.³¹

Oettingen developed the concepts of “tonicity” [*Tonicität*] and “phonicity” [*Phonicität*] by expanding Helmholtz's ideas of overtones and undertones to define major and minor triads. Helmholtz had defined overtones as the series of harmonic partials that extended upwards from the fundamental, and “under tones” as the possible fundamentals that could be associated with a given partial tone.³² Oettingen defined tonicity in terms of an interval or chord that shared a common “tonic fundamental.” In contrast, he defined the “phonic overtone” as the lowest common partial shared by a chord or interval. The major triad c^2, e^2, g^2 was “tonically consonant” because the chord was consonant with the fundamental of c , and it was “phonically dissonant” because it was dissonant to its phonic overtone of b^6 . Conversely, the minor triad c^2, e_b^2, g^2 was “tonically dissonant” with its

³⁰ Chien-Chang Yang, “Music as knowledge: Hugo Riemann's theory of musical listening and the foundation of German Musikwissenschaft,” Ph.D. diss., University of Chicago, 2002, 35.

³¹ Moritz Hauptmann, *The Nature of Harmony and Metre*, 17.

³² Helmholtz, *On the Sensations of Tone*, 44. Only later would Riemann modify the concept of undertones to apply to a series of partials that extend downward from the fundamental.

tonic fundamental of a_b, and it was “phonically consonant” with the phonic overtone of g⁴.³³ In this way, Oettingen presented major and minor triads as two sides of a mirror, with neither having more positive value than the other.³⁴

In 1869, Riemann became interested in Oettingen’s theories of harmonic dualism after reading a scathing review of Oettingen’s *Harmoniesystem*.³⁵ From that point on, Riemann adopted the principles of harmonic dualism, and even developed a more extreme position than other dualists, using the concept of acoustical undertones as the basis for his entire musical system.³⁶ In one of his earliest articles, “Tonverwandtschaft” from 1873, Riemann summarized Oettingen’s *Harmoniesystem in dualer Entwicklung* with commentary. “Tonverwandtschaft” is also significant because it contained Riemann’s first use of the term undertones:

For us, overtones and undertones really exist, though not as tones accompanying a given tone. Rather, they are free, as related tones, which can be fixed together with the fundamental (if we want to say it that way), and which are nevertheless easily understood either in simultaneity or in succession.³⁷

He postulated the existence of an undertone series to justify the minor triad as a consonant harmony.³⁸ In Riemann’s system, the undertone series extended downward from the fundamental tone as a mirror image of the overtone series, and the ratios of

³³ Henry Klumpenhouer, “Dualist tonal space and transformation in nineteenth-century musical thought,” in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen, 465.

³⁴ Arthur von Oettingen, *Harmoniesystem in dualer Entwicklung: Studien zur Theorie der Musik* (Dorpat, Leipzig: W. Gläser, 1866), 5.

³⁵ [J.S.], “Ein neues Harmoniesystem,” *Neue Zeitschrift für Musik* 65 (1869): 349–52.

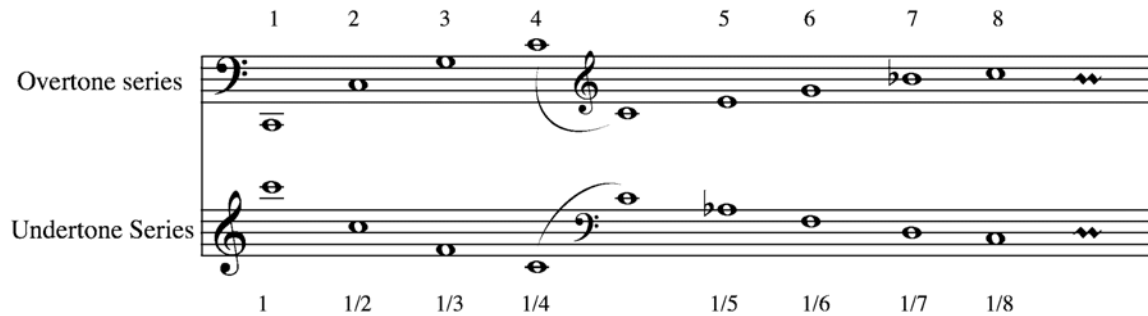
³⁶ Rehding, *Hugo Riemann and the Birth of Modern Musical Thought*, 15. Riemann was the first to conceive of undertones as a separate entity from overtones, or as generated downward from a fundamental.

³⁷ Riemann, “Tonverwandtschaft,” *Neue Zeitschrift für Musik* 69 (1873): 30.

³⁸ Riemann, *Musikalische Logik* (Leipzig: C.F. Kahnt, 1874), 18–19.

vibration were reciprocals of the overtone series. In addition, while the major triad (4:5:6) is contained in the overtone series, the undertone series yields a minor triad (1/4:1/5:1/6).

Figure 3: Overtone and Undertone series



Riemann modified his concept of undertones throughout his career as he sought varying means of justification. In his dissertation from 1873, “Über das musikalische Hören” (On musical hearing), Riemann developed the hypothesis that undertones are generated in the ear.³⁹ Riemann based his hypothesis on Helmholtz’s idea that the fibers in our ear vibrate with the musical tone and its overtones. Rather than describing the ear in terms of linear physics where there is always an objective solution, Helmholtz developed a theory of the non-linearity of the ear. Helmholtz believed that the ear could produce sounds that were not actually present in the sound wave produced by the instruments.⁴⁰ Our ear produces aural harmonics from the interactions between the frequencies of a fundamental and its overtones, or between multiple fundamentals in a chord. Riemann took these ideas and applied them to his concept of undertones. He conceived of undertones as only audible in our perception. Riemann tied his argument for undertones to natural science by relating it to current knowledge of the physiology of the

³⁹ Riemann, *Musikalische Logik*, 12. “die den Untertönen eines angegebenen Tones entsprechenden Fasern der Membrana basilaris schwingen partiell mit und wir haben daher die Vorstellung der Untertöne implicite.”

⁴⁰ *The New Grove Dictionary of Music and Musicians*, s.v. “Physics of Music” (by James F. Bell, C. Truesdell and Murray Campbell), <http://www.grovemusic.com/> (accessed 17 May 2007).

ear, yet Riemann seems to take the undertone series as a given in *Musikalische Logik*. The undertone series produced nice ratios in a reciprocal relationship to the overtone series and provided Riemann with support for minor tonality and his explanation of consonance and dissonance.

In “Die objective Existenz der Untertöne in der Schallwelle” (The objective existence of undertones in the sound wave) from 1875, Riemann revised his conception of undertones from existing in the basilar membrane of the ear to existing in the sound wave itself as a natural phenomenon. In the opening of the article, Riemann mentioned precedents to his ideas in the work of Tartini, and throughout, he relied heavily on theories of combination tones. Riemann also defended the existence of undertones with an 1875 experiment – he hit a key on the piano and believed that he could hear the undertones contained in the sound.⁴¹ Shifting the location of the undertones from the ear to the sound wave allowed Riemann to draw more heavily on acoustic theory.

In 1882, he extended the historical justification for undertones and created a line of dualist thinking stemming back to Zarlino, Rameau, Tartini, Hauptmann, Oettingen, and ending with Riemann himself.⁴² In 1891, after criticism that other theorists could not replicate and confirm his experiments, Riemann revised his thesis and continued to claim the existence of undertones in theory, but accepted that they were inaudible because of interference in their sound waves that cancels them out:

⁴¹ Helmholtz, *On the Sensations of Tone*, 365. Here, Helmholtz criticized Riemann: “Perhaps the author [Riemann] has been deceived by the circumstance that with very resonant instruments (especially older ones) any strong shake, and therefore probably a violent blow on the digitals, will cause some one or several of the deeper strings to sound its note.”

⁴² Riemann, “Die Natur der Harmonik,” in Paul G. Waldersee, ed., *Sammlung Musikalischer Vorträge* 40 (1882). Riemann later expanded on this line of reasoning in his *Geschichte der Musiktheorie im IX.-XIX Jahrhundert* (Leipzig, 1898).

In *Katechismus der Musikwissenschaft*, p. 79, [I] finally offered the scientific proof as to why, despite the commensurability of vibration forms, a tone cannot produce the undertone series by means of summation of its vibration. With this, the question is finally settled. (Each tone necessarily produces the whole series of undertones, but each undertone is produced multiple times, in accordance with its ordinal number – The second twice, the third three times, etc. – just so that they necessarily cancel each other out by means of interference.)⁴³

Finally in 1905, Riemann ceased basing his arguments on undertones and physical acoustics. He still believed that undertones existed in theory, but he asserted that it was irrelevant whether their physical existence could be proven.⁴⁴ In “Das Problem des harmonischen Dualismus” (The problem of harmonic dualism), Riemann did not only reject his previous attempts to explain minor harmony using undertones, but he also rejected the tradition of explaining harmony using overtones, or any other acoustic phenomena. He wrote, “the emancipation of the theory of consonance from real overtones, already so recognized as necessary even by Oettingen, is in fact absolutely essential.”⁴⁵

In music theory, it was thought that principles must be legitimated outside of the human element – principles must be seen to follow a “higher imperative,” rather than be connected with the relativistic modes of human actions/perceptions.⁴⁶ Throughout his career, Riemann grappled with these ideas, both searching for physical evidence of undertones in the human body and the sound wave, and, on the other hand, proclaiming

⁴³ Hugo Riemann. “Untertöne.” *Musik-Lexikon*, 5th ed. (Leipzig: Max Hesse, 1900). Translated in Rehding, *Hugo Riemann and the birth of modern musical thought*, 197–98.

⁴⁴ Riemann, “Das Problem des harmonischen Dualismus,” *Neue Zeitschrift für Musik* 51 (1905): 3–5, 23–26, 43–46, 67–70.

⁴⁵ *Ibid.*, 24. Translation by Daniel Harrison, *Harmonic Function in Chromatic Music*, 257.

⁴⁶ Rehding, *Hugo Riemann and the Birth of Modern Musical Thought*, 35.

the irrelevancy of their actual existence and using his subjective experiment at the piano as evidence.

From a Note to a Scale

All of Riemann's early theories on tonality and harmony can be traced to the influence of dualistic harmony on his conception of a single pitch as containing the representation of its overtones and undertones. Riemann defined tonality as "the special meaning that chords receive through their relationship to a fundamental sonority, the tonic triad."⁴⁷ The tonal system in its entirety could be reduced to a single chord, which could further be obtained from a single tone and its overtones. For Riemann, the single tone was the seed that encapsulated the entire tonal system: a single tone "contain[s] the principle of harmony in the uniformity of its vibrations."⁴⁸ Riemann used the concept of a *Klang*, or a fundamental tone plus its overtones or undertones, to define his entire system of tonality (triads, consonant and dissonant intervals, etc.). In addition, he believed that a single tone does not satisfy us: we need a second tone to make the first intelligible in a temporal progression.

This process of listening was supposed to be an active process that required the full concentration of the listener to relate all tones to those that came before; Riemann did not condone passive listening.⁴⁹ The system of tonality requires us to use our mind to compare "tones to one another, and in our desire to place primary emphasis on one tone,

⁴⁷ Riemann, "Tonalität," *Musik-Lexikon*, 5th ed. "die eigentümliche Bedeutung, welche die Akkorde erhalten durch ihre Bezogenheit auf einen Hauptklang, die Tonika."

⁴⁸ Mark McCune, "Hugo Riemann's *Ueber Tonalität*: A Translation." *Theoria* 1 (1985): 137.

⁴⁹ Rehding, *Hugo Riemann and the Birth of Modern Musical Thought*, 3.

hearing all others according to their relationship to it.”⁵⁰ Riemann’s conception of active listening required listeners to make connections between successive notes of a melodic line, and between the interactions of the partials of successive or simultaneous pitches.

Similarly, Riemann defined the Western diatonic scale in terms of Hauptmann’s dialectics, in which notes of the scale and chords are not isolated tones, but they define the tonal center through processes of affirmation and negation. In his description of the major scale in “Über Tonalität” (On Tonality), Riemann showed how each scale degree is interpreted as either an affirmation of a negation of the tonic, and he appropriated Hauptmann’s three-chord model to apply to the notes of the scale.

From Riemann’s point of view, our perception of the notes in the scale is based on the overtone series:

[The] overtones of C are G, E, and C. We perceive these tones in the course of a melody as points of rest, as sectional dividers; since these tones relate to C by their occurrence in its overtone complex, ...we sense them as reminiscences of C..., in contrast to the above concept of “negation”—as an affirmation of the tonic.⁵¹

Riemann’s treatment of each of the notes in the scale parallels his hierarchical conception of the scale. He began by defining C as the tonic, the guiding fundamental, which makes up what I will label as Level 1 (See Figure 4). He then defined G, E, and C, the overtones of C, which were the pillars or the “points of rest,” to which all of the other tones were related (Level 2). It is significant that these are also the notes of the C-major triad, which Riemann viewed as the guiding tonic chord in his conception of harmonic function.⁵²

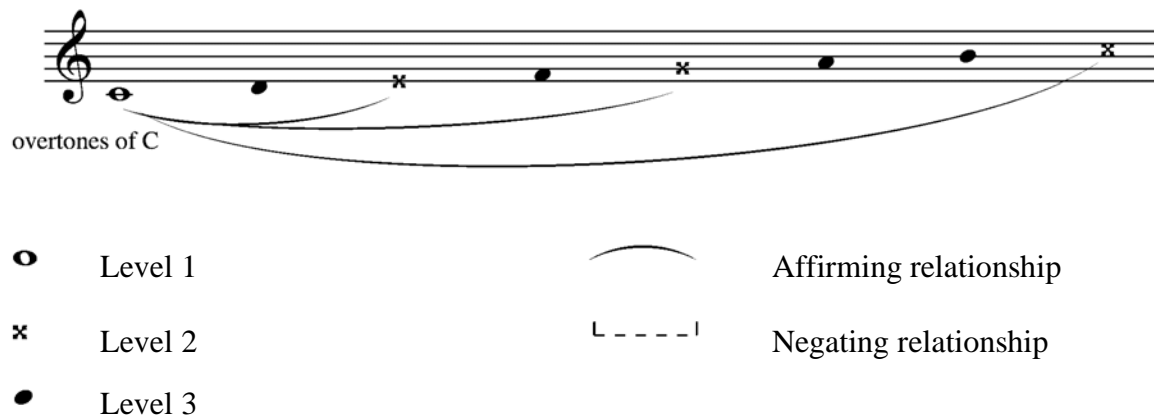
⁵⁰ Rehding, *Hugo Riemann and the Birth of Modern Musical Thought*, 3.

⁵¹ McCune, “Hugo Riemann’s *Ueber Tonalität*,” 143.

⁵² As we will see, his bias toward these notes is apparent in his deriving all the other notes from their relationship to these overtones of C. He takes this as a given, but that is only because he already claimed his acceptance of the progression I-IV-I-V-I as the essential tonal progression.

Next, he defined the other tones of the scale, not as separate entities, but only in terms of their relation to the tonic triad. They were simply notes that fell between these pillars, and were “completely indeterminate,” until he could characterize them as either affirming or negating the central notes contained in Levels 1 and 2. These notes are D, F, A, and B, and they make up Level 3.

Figure 4: Levels of Hierarchy in the major scale



Riemann defined D as “negative” to C and E since it is not contained in the first few notes of either of their overtone series (Figure 5a). However, D obtains a fixed character by being the fifth of G; it therefore affirms G, giving the note G “a certain independence from C” (Figure 5b).⁵³ He further postulated on the amount of independence given to G by arguing that if an F# were inserted between E and G, it would affirm D and negate G, thereby giving the G tonic meaning that would cause us to forget the C fundamental, with which it forms a dissonant tritone (Figure 5c). Riemann’s only justification in bringing the F# into his arguments is to make the relationship between G and D stronger by implying a secondary dominant chord based on D to

⁵³ McCune, “Hugo Riemann’s *Ueber Tonalität*,” 143.

elevate the status of G. The note G takes on the role of the fundamental of D, thereby acquiring an “independence that contests the rank of C.”⁵⁴ Because we interpret G as both the fundamental of D, and as an overtone of C, it receives an unfixed character and presses the melody to continue further.

Figure 5: Affirming and Negating Relationships in the Major Scale



Having affirmed G, the upper-fifth of C, Riemann turned to the lower-fifth, F. The case of F is significant since it both affirms and negates C depending on the octave (Figure 5d). F diminishes the power of C because it is “completely foreign to the other [C].” From the F, “C is...reawakened in our ‘memory,’ but not as a fundamental tone firmly appearing through a vassal, so to speak; it itself appears as a slave in the retinue of another tone.” Riemann’s argument can be summarized: C has been negated by D, affirmed by E, and made uncertain by F.⁵⁵

⁵⁴ McCune, “Hugo Riemann’s *Ueber Tonalität*,” 145.

⁵⁵ Ibid.

After he designated the upper- and lower-fifths as the most significant in terms of their relationship to the tonic, Riemann defined the last two notes that fill the interval between G and C. He proposed that we should tune A as an overtone of F, because if A were tuned as the fifth of D, that would stress the D-chord, and would result in a stronger affirmation of G: “C would be completely forgotten, and G would become tonic” (Figure 5e).⁵⁶ It was crucial for Riemann to stress the independence of G as the upper-fifth of C, but not so much as to completely negate the tonic key. He defined the leading tone, B, as an overtone of G that affirmed G and negated C (Figure 5f).

In Riemann’s system, each note of the scale either affirmed or negated the tonic in a complex web of relations based on overtones, and particularly on fifth-relations. The article represented Riemann’s early attempt to unite Hauptmann’s ideas of affirmation and negation with acoustical ratios of consonance, yet it is curious that Riemann avoided mention of undertones or any emphasis on the minor scale. He devoted a large section of the article to defining the basis for the major scale, which he referred to as “our modern scale,” and did not give equal treatment to the minor scale, as he would in his later works that became more self-consciously devoted to the ideals of harmonic dualism.

Musical Logic

In essence, all of Riemann’s theories of tonality proceed from the belief that the overtones in simple proportion to the fundamental are the most important. Next, Riemann defined the formation of the major triad from these overtones, and the major scale as the linear representation of an expanded tonic triad. Finally, Riemann’s conception of

⁵⁶ McCune, “Hugo Riemann’s *Ueber Tonalität*,” 145.

tonality was based on the interactions between the overtones and undertones of the notes of the scale.

In his *Musik-Lexikon*, Riemann differentiated his modern view of tonality from that of Fétis and Rameau, who based their theories on the scale, with a “tonic” as the beginning and concluding note.⁵⁷ Riemann stated that his new theory of harmony was based on chords, yet all of Riemann’s theories stem from his concept of a single tone. Riemann believed that we hear single tones as representatives of chords and that we hear chord progressions in terms of a principle chord to which all the others can be related.⁵⁸ With his ideas on musical logic, Riemann applied the same principles he used for single-sounding notes to chord progressions and complex musical compositions. Riemann developed the idea of musical logic to prescribe boundaries for possible harmonic progressions. In “Musical Logic,” he defined the cadential progressions I-IV-V-I in major and I-V-IV-I in minor as the basic harmonic prototypes that form the basis of tonal music and embody musical logic. Drawing on Hauptmann’s model of a “triad of triads” to establish tonality, Riemann defined these progressions in similar terms of thesis, antithesis, and synthesis.

Hauptmann theorized a tripartite process that defines the tonal center: 1) tonic triad is stated; 2) a fifth-related triad de-centers the position of the first triad, making it come into opposition with itself; 3) the second fifth-related chord confirms the first chord as tonic. Riemann expanded Hauptmann’s conception by adding a temporal perspective,

⁵⁷ Riemann, “Tonalität,” *Musik-Lexikon*, 5th ed.

⁵⁸ Riemann, *Geschichte der Musiktheorie*, 2nd ed. (Berlin, 1920), 523. In addition, Riemann applied his theories to monophonic melodies and modal chant: “Even the simple monophonic melody set down in the preserved monuments of ancient art rests completely on a harmonic foundation.” [Auch die einstimmige, einfache Melodie, wie sie in den erhaltenen Denkmälern antiker Kunst vorliegt, beruht durchaus auf harmonischer Grundlage.] See his *Geschichte der Musiktheorie*, 2nd ed. (Berlin, 1920), 471.

in which the “cold and meagre” plagal cadence, I-IV-I, which emphasized the lower-dominant, occurs before the “full and satisfying” perfect cadence, I-V-I, to get the complete progression: I-IV-I-V-I.⁵⁹ He also combined it with the categories of thesis, antithesis, and synthesis that Hauptmann derived from the ideas of Fichte and Hegel. Riemann eliminated the restatement of the tonic chord to arrive at the model I-IV-V-I in major. In this progression, the tonic carried the thetic function, the subdominant occupied the antithetic function, and the dominant had the synthetic function.⁶⁰

Defining tonality [*Tonalität*] in his *Musik-Lexikon*, Riemann described the “bold but forceful and sweet-sounding” progression C-A \flat -C-E-C as embodying the features of the modern theory in that all harmonies were interpreted in relation to the tonic C major chord (Tonika – Gegenterzklang – Tonika – schlichter Terzklang – Tonika).⁶¹ Rather than using an example of a diatonic chord progression, such as his prototypical “greater cadence” [*große Kadenz*], Riemann used one that emphasized chordal relationships centered around the tonic in mirror images.

In order to tie his idea of the “greater cadence” to actual composition, Riemann allowed this model to be expanded through the idea of an embedded “cadence-within-the-cadence” [*Kadenz innerhalb der Kadenz*]. In this process, a cadential progression is inserted into the thetic stage of the “greater cadence”. With the idea of cadential expansion, Riemann could read any composition in terms of his cadential model: “every melodic phrase, every ornamental flourish,” could be interpreted as moving through the sequence of thesis, antithesis, and synthesis, so that the process of cadential expansion

⁵⁹ Rehding, *Hugo Riemann and the Birth of Modern Musical Thought*, 69.

⁶⁰ Riemann, “Musikalische Logik,” 3–4.

⁶¹ Riemann, “Tonalität,” *Musik-Lexikon*, 5th ed.

pervaded multiple levels of musical structure.⁶² To illustrate how the principles of cadential expansion exist in free composition, Riemann analyzed the opening phrase of the Adagio from Beethoven's Piano Sonata in F minor, op. 2, no. 1.

Example 1: Riemann's analysis of Beethoven's Piano Sonata, op. 2, no. 1, II

Riemann's analysis: I V I V I V

Riemann divided the phrase into three sections: mm. 1-5 represent an extended thesis; mm. 5-6 give a complete cadence with the stress on IV; mm. 6-8 include a stressed lower dominant and then suspension leading to the tonic.⁶³ In addition to discussing the harmony, Riemann dissected the melody of the phrase in terms of the categories of thesis, antithesis, and synthesis. For example, he diagrammed the first measure:

Figure 6: Riemann's analysis of melody (m. 1)



⁶² Riemann [pseud. Hugibert Ries], "Musical Logic: A Contribution to the Theory of Music," trans. Kevin Mooney, *Journal of Music Theory* 44/1 (Spring 2000): 105–6.

⁶³ *Ibid.*, 105.

In Riemann's analysis, Hauptmann's categories of thesis, antithesis, and synthesis are stripped of their philosophical overtones and become mere tools and labels to create a system of musical grammar. This system, which ascribes a label of I, IV, or V to each subsection of the phrase (Riemann even labels each note of the turn in m. 1), represents the starting point for his system of functional harmony.

There is no specific mention of harmonic dualism in "Musical Logic" and little discussion of minor harmony, however, Riemann's belief in dualism is evident from his discussion of major and minor metric accents.⁶⁴ Similarly, Riemann builds his system of analyzing rhythm and meter as a parallel to his system of harmony and melody. Rhythm and meter are connected as are harmony and melody: "A melody with no connection to harmony and a rhythm with no relation to meter are equally nonsensical."⁶⁵

We can see a progression through Riemann's works from his earliest works that contained a stronger influence from Hauptmann's ideas, to a period in which Riemann utilized the methods of Arthur von Oettingen. However, even in "Musical Logic," Hauptmann's dialectic approach was nothing more than a pragmatic tool for Riemann. "Musical Logic" is an important work because it is valuable as a case study documenting the transmission of Hauptmann's ideas to Riemann, because it documents Riemann's struggle for intellectual maturity and independence, and because it provides a compact statement of the issues that Riemann would tackle in his work for the following forty years.⁶⁶

⁶⁴ Riemann, "Musical Logic: A Contribution to the Theory of Music," 92.

⁶⁵ *Ibid.*, 113–14.

⁶⁶ Mooney, "Hugo Riemann's Debut as a Music Theorist," 96.

III. RECEPTION

During the 1870s, Riemann furthered the ideals of science in his harmonic theories, drawing heavily from the empirical methods of science and from Helmholtz's study of acoustics and physiology. Riemann developed the idea of undertones as the basis for his theory of harmonic dualism. Because his concepts of undertones and dualism were often criticized, he was forced to employ varying defenses to justify his theory of undertones. Inspired by Chrysander's compulsion to make music theory scientific and objective, Riemann first tried to ground his theories in acoustics and the methods of hard science, yet in some ways these methods conflicted with his goal of investigating the more subjective questions of how we hear music.

Undertones

Riemann responded to harsh criticism of his theory of undertones by constantly seeking new evidence to defend their existence. Many critics dismissed attempts to justify his theories with an amateurish experiment, in which he generalized the existence of undertones from his individual belief in his ability to hear the lower pitches of the undertone series when he depressed a key on the piano.

One of Riemann's earliest critics, Karl Franz Emil von Schafhautl, denounced Riemann's questionable methods in his experiment at the piano to establish the existence of undertones. The experiment, which was based purely on Riemann's subjective interpretation of sound, could not be replicated and confirmed by others, and therefore

Schafhäütl dismissed it as unscientific. Shortly after the publication of Riemann's first treatise on harmony, *Musikalische Syntaxis*, Schafhäütl wrote the article "Moll und Dur," which appeared in the *Allgemeine Musikalische Zeitung* in 1878. Schafhäütl devoted a small section of the large article to Riemann's theories, calling Riemann a "new Dualist." Criticizing Riemann's assertion in *Musikalische Syntaxis* that he can hear undertones, Schafhäütl wrote: "the most recent dualist, Dr. Hugo Riemann tells us that he and nobody else, except perhaps Aristotle two thousand years ago, has heard these undertones, which alone are supposed to explain the consonance of the minor triad."⁶⁷ Schafhäütl's dismissal of undertones and spelling the minor triad downward illustrate prevalent attitudes toward dualism at the time. Rather than dissecting specific points of Riemann's argument, Schafhäütl only drew attention to Riemann's concluding remark of

Musikalische Syntaxis:

I admit that hearing the sympathetic undertones also has its difficulties. For years, I have been personally eager to discover the phenomenon that explains the minor consonance, and it is perhaps no wonder, therefore, that I heard, what no one has heard until now, except perhaps Aristotle two thousand years ago.⁶⁸

Following this passage, Riemann furthered his proclaimed connection to Aristotle, citing a passage from Aristotle's *Problems* in Greek, which discussed the two notes, *nete*

⁶⁷ Schafhäütl, "Moll und Dur in der Natur, und in der Geschichte der neuern und neuesten Harmonielehre," *Allgemeine Musikalische Zeitung* XIII/6 (6 February 1878): 90. "der neueste Dualist Dr. Hugo Riemann erzählt uns, dass er und sonst Niemand, als vielleicht Aristoteles allein vor 2000 Jahren, diese Untertöne, welche *allein die Mollconsonanz* erklären können, gehört habe."

⁶⁸ Riemann, *Musikalische Syntaxis: Grundriss einer harmonische Satzbildungslehre* (Leipzig: 1877), 123. [Ich gebe zu, dass Hören der mittönenenden Untertöne auch seine Schwierigkeiten hat, ich bin persönlich seit Jahren darauf aus gewesen, das Fänomen zu entdecken, welches die Mollkonsonanz erklärt, und ist es vielleicht darum kein Wunder, dass gerade ich hörte, was bisher noch niemand gehört, außer vielleicht vor 2000 Jahren Aristoteles.]

diezeugmenon and the *hypate meson*, which are an octave apart and in a ratio of 2:1.⁶⁹

While Schafh utl made Riemann’s claim that he is one of a few that can hear undertones seem absurd, Riemann attempted to bolster his claim with historical support and give his theories a lineage going back to Classical authors.

Unlike other recent theorists such as Hauptmann, Oettingen, and Otto Tiersch, to whom Schafh utl devoted sections discussing the technical aspects of their works, Schafh utl limited his treatment of Riemann’s theories strictly to surface critique and dismissal. Schafh utl compared Riemann’s belief that he could hear undertones to the well-known anecdote of the horn player who cannot play soft enough to satisfy the conductor, and finally satisfies the conductor by raising the instrument to his mouth and pretending to blow. The conductor tells him it was good, but could still be more *piano*.⁷⁰ In the same way that the conductor thought he heard the horn only because he expected to, Schafh utl labeled Riemann as someone who was duped into hearing something that did not actually exist because of the expectation to hear them. As an acoustician and inventor, Schafh utl directed his criticism at the lack of scientific rigor in Riemann’s claim to hear undertones.

Adolf Lindgren, a Swedish music critic and historian, discussed Riemann’s undertone-theory in two articles from 1886 and 1890. In the first, Lindgren refuted the theory primarily using practical examples, and in the second, he tried to incorporate more scientific data. In “Konsonanz und Dissonanz,” Lindgren argued that there was neither

⁶⁹ Andrew Barker, ed., *Greek Musical Writings*, vol. 2, *Harmonic and Acoustic Theory* (Cambridge, New York, and Melbourne: Cambridge University Press, 1989), 96. “Why is it that if one plucks *nete* and then damps it, *hypate* alone seems faintly to sound? Is it because when *nete* is ceasing and dwindling it becomes *hypate*?”

⁷⁰ Schafh utl, “Moll und Dur,” 90–91.

practical nor theoretical evidence to support Riemann's theory of undertones.⁷¹ Lindgren performed his own experiment at the piano using paper-riders, and he concluded that Riemann's discovery of undertones at the piano was based on an error. Lindgren asserted that there was no proof that undertones existed in the sound wave. For Lindgren, it was illogical for Riemann and other proponents of his undertone theory to insist that we should hear overtones in major chords, yet hear undertones in minor chords.⁷²

In 1890, with the publication of Carl Stumpf's second volume of *Tonpsychologie* Lindgren wrote his second article against Riemann's theories citing Stumpf's work as convincing proof that the "Riemann'sche Theorie" of the objective existence of undertones was wrong.⁷³ Lindgren discussed Stumpf's experiments that disproved Riemann's theories of undertones, and he praised the systematic work of Stumpf, over Riemann's "unfledged undertone theory."⁷⁴

Riemann responded to Lindgren's criticism by applying both a scientific and historical argument. Using historical justification, Riemann stated that the Greeks considered the major modes (phrygian and lydian) as orgiastic in relation to the minor (dorian and mixolydian), and aesthetically as inferior.⁷⁵ Riemann countered Lindgren's argument that Stumpf's theories did not disprove dualistic harmony, but that they in fact

⁷¹ Adolf Lindgren, "Konzonanz und Dissonanz." *Allgemeine Musik-Zeitung* No. 38-44 (1886).

⁷² *Ibid.*, 421.

⁷³ Lindgren, "Die Undertontheorie nochmals geschlagen." *Allgemeine Musik-Zeitung* vol. 17 no. 30/31 (8 Aug 1890): 375.

⁷⁴ *Ibid.*

⁷⁵ Lindgren, "Konzonanz und Dissonanz," 421.

give his theories a “solid scientific basis.”⁷⁶ Riemann pointed to the scientific phenomenon of interference in the sound waves that cancelled out the undertones with reference to scientific charts. Defending his undertone hypothesis from the criticism that his experiment lacked scientific method, Riemann relocated the basis of his undertone theory to physical acoustics. In Riemann’s argument, since undertones could not be physically heard, the charges of his critics who all sought experimental confirmation for undertones became irrelevant.

Tonality

In 1901, Georg Capellen, a music theorist and critic in Osnabrück, surveyed the inconsistencies in Riemann’s dualistic conception of harmony.⁷⁷ In “Die Unmöglichkeit und Ueberflüssigkeit der dualistischen Molltheorie Riemann’s” (The impracticality and needlessness of Riemann’s dualist theory of minor), which appeared in the *Neue Zeitschrift für Musik* in 1901, and *Die Zukunft der Musiktheorie* (The future of music theory), published in 1905, Capellen pointed out the inconsistencies in Riemann’s theories and developed his own “monist” map of tonality.⁷⁸

Echoing Riemann’s earlier critics, Capellen criticized Riemann’s insistence on clinging to his undertone hypothesis when it was a purely hypothetical concept and not

⁷⁶ Riemann, “Die ‘abermals geschlagenen’ Untertöne,” *Allgemeine Musik-Zeitung* 17/36 (5 Sept 1890): 422. Riemann and Stumpf would have a later dispute around the turn of the century.

⁷⁷ Capellen (1869-1934), an important theorist at the time, is known for a treatise on an “exotic” musical style, his refutation of harmonic dualism, and a critique on Simon Sechter’s application of fundamental bass theory to Wagner. See David W. Bernstein, “Georg Capellen on *Tristan und Isolde*: Analytical Systems in Conflict at the Turn of the Twentieth Century.” *Theoria* 4 (1989): 35.

⁷⁸ Georg Capellen-Osnabrück, “Die Unmöglichkeit und Ueberflüssigkeit der dualistischen Molltheorie Riemann’s.” *Neue Zeitschrift für Musik* 97/45 (6 November 1901); Capellen, *Die Zukunft der Musiktheorie* (Leipzig: C. F. Kahnt, 1905).

supported by experimental data. For Capellen, Riemann’s mistaken belief in undertones made it impossible for him to build a theoretical system on a “scientific basis.”⁷⁹

Capellen, in contrast, derived major and minor chords and tonal relations from a single principle: the overtone series, which could be verified scientifically.⁸⁰ Capellen developed the concept of a ninth chord, which was formed from two or three fundamental tones and their overtones. The ninth chord served as raw material from which Capellen could derive other chords. Similarly, in his “monist” concept of tonality, the minor triad was a derivative of two major chords. For example, he combined the A-major and C-major triads to form an A-minor triad.⁸¹ The C# in the A-major chord, which is merely an overtone of A, is cancelled by the C♭, which is a fundamental:

Figure 7: Capellen’s derivation of a minor triad



The section in Capellen’s article that deals with tonality is centered on explaining cadential structures. Capellen disputed the parallels drawn by Riemann between natural cadences in major (I-IV-V-I) and in minor (I-V-IV-I). For Capellen, the minor cadences that Riemann used to support his dualistic theories were theoretical constructs that sounded unnatural in practice. In addition, he believed that Riemann’s minor cadences

⁷⁹ Capellen-Osnabrück, “Die Unmöglichkeit und Ueberflüssigkeit der dualistischen Molltheorie Riemann’s,” 531.

⁸⁰ David W. Bernstein, “Georg Capellen on *Tristan und Isolde*,” 35.

⁸¹ Bernstein, “Georg Capellen on *Tristan und Isolde*,” 36-7.

were not true analogues to major and could not be explained using Riemann's undertone theory.

Riemann articulated his response to Capellen and other critics of his harmonic theories in "Das Problem des harmonischen Dualismus" (1905). The article also marks the reorientation of Riemann's harmonic theories away from acoustics and scientific empiricism toward a psychological justification for major and minor. Riemann rejected the idea of using overtones or other acoustic phenomena as the basis for consonance, however, his acknowledgment was worded in a way that did not completely deny his earlier work:

I have myself grappled long enough with these specious arguments from [acoustic] phenomena and have written many pages, drawn many an awkward conclusion. I do not exactly have to retract these today, but rather I may point to them as proof of the artificial convolutions and equivocations that result from deriving consonance from [acoustic] phenomena.⁸²

In addition, Riemann's rejection of an acoustic basis for consonance created an argument against Capellen's theories, which used overtones as the fundamental principle.

Riemann echoed a common criticism against an acoustic foundation of music that the abandonment of the higher dissonant partial tones in favor of the first six was completely arbitrary.⁸³ He also explained that if we define minor as secondary and derived from major, we must accept that the use of minor keys arose later than major, and this is inconsistent with the historical development of music.⁸⁴ Riemann criticized theorists who constructed a complicated "artificial device" [*künstlichen Einheit*] to

⁸² Riemann, "Das Problem des harmonischen Dualismus," 67, quoted in Harrison, *Harmonic Function in Chromatic Music*, 247.

⁸³ Riemann, "Das Problem des harmonischen Dualismus." *Neue Zeitschrift für Musik* 101 (1905): 4.

⁸⁴ *Ibid.*, 5.

explain the c minor triad as a combination of the fifth from c-g from the C major triad, the e \flat -g from the E \flat major triad, and the c-e \flat from the A \flat major triad.⁸⁵ He claimed that while Capellen called himself a “monist,” his system was not truly based in harmonic monism because he formed minor chords from two, or even three, fundamentals.⁸⁶

Although Riemann believed that he divorced his harmonic theories from a reliance on physical acoustics in “Das Problem des harmonischen Dualismus,” he merely relocated the explanation of major and minor tonality from a basis in concepts of overtones and undertones, to arising from ratios of frequency and wavelength.⁸⁷ Riemann showed that for the major triad, the proportion of frequencies was 4:5:6, and for the minor triad, the proportion of wavelengths was also 4:5:6. Riemann’s goal was to explain minor consonance without using physical or empirical evidence for undertones, yet we can see that he constructed the meaning of the proportional relationship between wavelength and frequency to reinforce his theory. As this equation indicates, wavelength and frequency are inversely proportional because we can consider wave speed to be constant:

$$\text{wave speed} = (\text{frequency}) \times (\text{wavelength})$$

$$v = f \times \lambda$$

Therefore, since major and minor triads are intervallic inversions, and their frequency and wavelength are inverse proportions, the relationship between frequency and wavelength of major and minor triads is obviously inversely proportional as well. As Daniel Harrison points out, Riemann’s use of frequency and wavelength to justify harmonic

⁸⁵ Riemann, “Das Problem des harmonischen Dualismus,” 23.

⁸⁶ Ibid.

⁸⁷ Ibid., 43.

dualism is problematic: what is the rationale for making frequency and wavelength the basis of harmonic consonance?⁸⁸

Although Riemann's shift from a theory of undertones to theories of wave frequency and wavelength may seem arbitrary, the reorientation of his thought allowed Riemann to concentrate on developing other ideas of musical perception. Riemann's discovery of Stumpf's work in psychology provided him with the freedom to move beyond Helmholtz's basis of consonance in overtones. As Riemann stated, "neither overtones nor combination tones could explain musical consonance. With regard to processes of hearing, physics provided inadequate information, and only musical psychology could provide meaningful results."⁸⁹

In music theory, it was considered necessary to legitimate ones principles outside of the human element in order for them to be perceived as following a "higher imperative" that was unconnected with the relativistic modes of human actions or perceptions.⁹⁰ The establishment of psychology as a legitimate discipline allowed Riemann to turn away from his problematic notion of undertones and replace questions of acoustics or physiology with psychological endeavors in the subjective investigation of perception and the interpretation of musical sounds.⁹¹

⁸⁸ Harrison, *Harmonic Function in Chromatic Music*, 258–9.

⁸⁹ Riemann, "Das Problem des harmonischen Dualismus," 25.

⁹⁰ Rehding, *Hugo Riemann and the Birth of Modern Musical Thought*, 35.

⁹¹ For example, Riemann developed the concept of a mental representation of sound in his late work: "Ideen zu einer 'Lehre von den Tonvorstellungen,'" in *Jahrbuch der Musikbibliothek Peters*, vol. 21/22 (Leipzig: C. F. Peters, 1914/15; repr. Vaduz: Kraus Reprint, 1965), 1–26; Robert W. Wason and Elizabeth West Marvin, trans., "Ideas for a Study 'On the Imagination of Tone,'" *Journal of Music Theory* 36/1 (Spring, 1992): 69–79.

Early in his career, Riemann derived the theory of undertones to make his work valid from an objective, scientific standpoint. As we have seen, however, when natural scientists evaluated Riemann's theories, they dismissed his concept of undertones because they could not be perceived or measured scientifically. Their reactions to Riemann's ideas of undertones and dualism brings to the fore the shifting attitudes in the sciences regarding the study of empirically quantifiable versus subjective processes.⁹²

Conclusion

In closing, I would like to return to Riemann's statement that characterizes his entire theoretical system:

Time will decide whether my system is worthy or not; if it can be successfully demonstrated that the principle itself is false, then the entire system will fall apart like a house of cards."⁹³

Today, we no longer accept his theories of undertones or harmonic dualism, yet other aspects of his musical system still influence our ideas about music.

Riemann's quest to explain all musical phenomena using theoretical reasoning can only be understood in the context of the quantifying efforts of nineteenth-century theorists to treat music as a scientific discipline. His goal of developing a scientific system to explain how we perceive music never changed, but the methodologies he

⁹² For example, at the time of the emergence of the human sciences, there was a prevalent attitude that the human sciences were subjective, whereas the natural sciences were objective. For Wilhelm Dilthey and Max Weber, as well as for Wilhelm Windelband and Ernst John Stuart Mill, the task of the scholar was to create criteria for "validity in explanation and description" that could lend scholarship in the human sciences the authority of the natural sciences. See Leon Botstein, "Cinderella; or Music and the Human Sciences. Unfooted Musings from the Margins," *Current Musicology* 53 (Fall 1992): 124.

⁹³ Hugo Riemann, "Die Lehre vom musikalischen Vortrag in der neusten Litteratur," 173.

employed evolved over time. Riemann did not limit himself to only drawing from certain disciplines, but he remained open to developments from the natural sciences, social sciences, and ethnomusicology.

The apparent shift in Riemann's work from the physiological to the psychological, and from the objective to the culturally relative, creates a musicological parallel to the trends in the development of the scientific disciplines. The examination of Riemann's works in terms of the influence of Hauptmann, Helmholtz, and Oettingen brings out the conflict between Idealist and empiricist thought, while the interaction between Riemann and his critics illuminates the tension between the natural sciences and the emerging psychological sciences.

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