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THE NATURE OF HARMONY.

BY

DR. HUGO RIEMANN.

TRANSLATED BY JOHN C. FILLMORE.

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DR. HUGO RIEMANN, OF HAMBURG.*

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The almost inconceivable number of text-books on the subject of harmony may be divided into two groups: theoretical systems of harmony, and books intended for teaching the practical use of chords; *i. e.*, what are called text-books on Thoroughbass. Each of these groups contains numerous examples, but those intended to introduce pupils directly to the practice of part writing over a figured bass are decidedly more in number than purely theoretical works, dealing with the significance of chords and their relations to one another. It has become customary, indeed, in these latter days, to introduce the practical instruction books with a chapter on theory, or to begin the separate chapters with some theoretical observations; but, in principle, the two methods of treating the subject of harmony have to be kept separate. The practical teaching of harmony, the practice in connecting chords according to the rules of polyphonic writing, is properly a part of the *art* of writing music, is the practical acquirement of the technic of composition. The theory of harmony, on the other hand, is a part of the *science* of music; it belongs in the domain of natural science, with which the art of music has to do only in so far as it can utilize the results of scientific investigation for its own practical purposes.

Scientific investigation in the domain of music concerns itself, primarily, with ascertaining the laws which govern *sounding bodies*, and is thus a department of *physics; i. e.*, the science of *acoustics.* Then, pursuing tones still further, and inquiring into the effects they produce on the human ear, and the mode in which those effects are produced, it becomes a special depart-

* A lecture, given at the Hamburg Conservatory of Music, February 4th, 1882.

ment of *physiology*. Finally, concerning itself with tone-perceptions, with the *mental effects* of these acoustic and physiological phenomena, and with the mental connections and relations of the sensations produced by sound, it enters the domain of *psychology*. Out of the results of scientific investigation in all the three fields of physics, physiology and psychology, we get the elements of an exact theory of the nature of harmony. It is the special function of this theory to provide, for the practical instruction in the art of composition, ways and means of grouping special details under general laws; of establishing comprehensive points of view and general rules; in short, its province is to systematize facts according to their true nature and laws, and, avoiding all arbitrary ways of looking at the facts, to provide a true system as a basis for the practical work of the student and composer.

At first, the contributions to such a theory based on scientific investigation were few and far between; it is only of late that the impulse given to scientific study in general has helped us forward considerably. The interest of practical musicians in the new science is still confined to the few, and has not yet become intense; but this is hardly to be wondered at when we consider that it is only within the past twenty years that our scientific knowledge has become sufficient to make it possible to classify discovered facts into a well-rounded system, available for practical use. The more the new way of looking at harmonic relations is seen to be positively useful and practical, the more will interest in laying scientific foundations for the art of music become widespread and lively. In the following pages I shall briefly show what benefit the practical teaching of music has already derived from exact science, and how much it may still hope to draw from such study in wholly new directions.

The oldest portion of our exact scientific knowledge in connection with harmony is that investigation into the nature of sounding bodies which produced *the mathematical definitions of the consonant intervals*. These definitions are ascribed to Pythagoras; but are, without doubt, much older than he. The well-known legend about the blacksmith's hammers of different weights, which led Pythagoras to the discovery of the relative numerical proportions of the intervals, is physically false as to its central fact. Pythagoras very likely got his facts about intervals, as determined by measuring the different lengths of string which produce them, from the Egyptian priests, with the rest of his philosophy of numbers; at least the elements of it.

Of course, the practical musician has a right to ask, "Of what use is it to Art and artists to know that when two strings sound the interval of an octave, they being of the same weight and tension, their lengths are related as 1 : 2; or if they produce a fifth, as 2 : 3; or a fourth, as 3 : 4?" And certainly the composer derives no *direct* benefit from knowing these facts; only the maker of instruments can apply them in his measurements, and the player in finding out how to stop his strings correctly. But, *indirectly*, we *do* gain a great deal from knowing that two tones at the interval of an octave stand in the simplest of all mathematical relations to each other, and that this simple relation does (in some as yet unexplained way) make its impression on our minds; since we really do perceive the octave to be a nearer and simpler relation of two tones than any other combination whatever. We certainly ought not to forget that no system of music can be practical which does not admit of looking at different tones from common points of view; such, for example, as that which allows us to give the same name to two tones an octave apart. We should hardly have come to this without the help of mathematics.

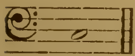
The Greeks designated tones an octave apart by the same sign (at least this is true of their latest notation), discriminating them, however, by a mark, just as we discriminate the once-marked $\bar{c}$ from small c. The occidental music system has done the same thing since the tenth, or even since the ninth century. The fifth and fourth, too, intervals whose relations are only less simple than those of the octave, play a correspondingly important part in practice. The key-note, fourth, fifth and octave, are the fundamental tones of the ancient no less than the modern scales. In the ancient system they were the only unchangeable tones; the second, third, sixth and seventh varied with the chromatic and enharmonic modes. I do not need to emphasize the importance of the fifth in our modern doctrine of keys and chords; especially in our view of the keys, everything turned on it, up to Moritz Hauptmann's time.

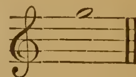
The third was not acknowledged at all as a consonance by the ancients. They did not use our consonant third, related as 4 : 5; the tone of their scale which corresponds to our third they defined theoretically as the lower octave of the fifth four times removed (c–g–d–a–e); and they considered it a dissonance because of its complicated mathematical relations (64 : 81). To the Arabs belongs the merit of having enriched the exact theory of music by the conception of the consonant third (see my "Studies in the History of Musical Notation," pp. 77–85). The so-called "Measure-theory of the Arabic-Persian theorists, which demonstrates the theory of intervals from a string divided into twelve equal parts, not only counts the major third (4 : 5) and the minor third (5 : 6) among the consonances, but also the major sixth (3 : 5) and the minor sixth (5 : 8). It looks very much as if their music was no more exclusively monophonic (*i. e.* in unison), than that of the Greeks; and as if they must have known the importance of the consonant chords. The oldest statements of this theory known to us (though they probably came down from a much older date), belong to the end of the thirteenth and the beginning of the fourteenth centuries; *i. e.*, to a time when our Western music had no theoretical conception of the consonant third; although it had considerably developed the polyphonic style (*discant, Fauxbourdon*).

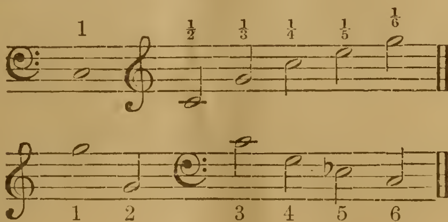
The man who first introduced the consonant third into our occidental music was *Ludovico Fogliani* (Musica theorica, 1529). He seems not to have been aware that this was anything new; nor was *Gioseffo Zarlino*, who did the same thing in 1558, in his "Instituzioni harmoniche." They both based their theories on those of the Greek theorists, Didymus and Ptolemy, who, among other divisions of the fourth (tetra-chord), used the third (4 : 5) consisting of a major tone (8 : 9) and a minor tone (9 : 10). But although the Greeks did happen on this third, they never regarded or treated it as a *consonance; and neither* Zarlino nor Fogliani had any occasion to disclaim the originality of their idea.

But Zarlino went further. He gave to the world the conception of *the consonant chord, in its double form of major and minor chord.*

In practice musicians had long ago discovered empirically the consonant harmonies which lie at the foundation of polyphony; but both theory and practical instruction were totally wanting in the conceptions necessary to define these formations. Zarlino, in his "Instituzioni" (I. 30 and III, 31), contrasted two modes of dividing a string, which he called the "harmonical" and the "arithmetical" (Divisione harmonica" and "Divisione aritmetica"). By the "harmonical" division of the string he meant the determining the pitch of the tones produced by the half, third, fourth, fifth and sixth of the string. By the "arithmetical" division, he meant the determining of the pitch of *multiples* of some small fraction of the string, = 1 : 2 : 3 : 4 : 5 : 6. If we take small c as a starting point, the series of tones represented by the lengths, $1 : \frac{1}{2} : \frac{1}{3} : \frac{1}{4} : \frac{1}{5} : \frac{1}{6}$ will correspond to the tones c, c′, g′, c″, e″, g″; that is to say, tones all of which belong to the major chord of c. On the other hand, if we start with the tone g″, the series 1 : 2 : 3 : 4 : 5 : 6 will represent the tones g″, g′, c′, g, e♭, c; that is, tones all of which belong to the *minor* chord *below* g (= c minor). Let us write both out, thus:







In other words: according to Zarlino, *the minor chord is mathematically the exact opposite of the major chord.* In fact, he uses the terms "Divisione harmonica" and "Divisione aritmetica" as meaning major and minor chord respectively. Whether Zarlino made this happy discovery himself, does not appear; but I know of no older theorist who has mentioned it. Unfortunately, this splendid idea of Zarlino's came to naught; whether it remained unnoticed or whether it was not understood, no matter; it disappeared for full two hundred years, and was then re-discovered by Tartini.

In all probability, the *thoroughbass* method, then just coming into vogue in text-books (although it had been growing into use in the practice of musicians for a long time before), was mainly responsible for the stifling of this germ of a rational system of harmony. There was, at that time, no comprehensive nomenclature for even the simplest and most commonly used chords. If the system which was to grow up had only been developed on the lines laid down by Zarlino, *i. e.*, if his principle of *duality* had been recognized, according to which the minor chord is the *reciprocal*, the *counterpart* and opposite of the major chord; then theory would have taken the direction in which the latest efforts of theorists are now being put forth; that of a consistent *dualism*, major being conceived of as formed *above* the fundamental tone, and minor *below* it.* Instead of this, the thoroughbass method took the lowest voice-part as its invariable starting point, and interpreted all chords from below upward.

The Italian organists, who had to accompany choruses in rehearsals and in public performances, used the figured bass as a convenient abbreviation, probably as early as the middle of the 16th century. No scores, such as we have now, were possible then, on account of the peculiar character of the notation. There were no bars to indicate the measures, and each voice containing notes differing in length from those of the others, had to be separate; so that playing from score was impossible. There were no scores, either written or printed; consequently, a conductor or organist who needed to watch all the voice-parts at once, had to help himself as best he could. The Italians did it by placing the voice-parts one above another, somewhat after the manner of a score, and then noting over the lowest voice, by means of figures, what intervals the other voices represented, counting from the bass. The Germans used another method, which they called the "Organ-tablature."

In order to comprehend the importance of thoroughbass in the practice and teaching of musical composition at that time, we must remind ourselves that all through that period a chord was looked on as a mere accidental combination of fragments of different voice-parts forming a consonant interval. As late as 1547, Glarean was of the opinion that a "discant" was a doubling of several voice-parts moving in different keys, so that, for example, in the same piece the bass might be in an "authentic" mode, and

* In my "Studien zur Geschichte der Notenschrift" (Chap. III, "The Revolution from the Conception in a Minor Sense to that in a Major Sense"), I have shown in detail that the ancients and also the Arabs invariably conceived tone relations from above *downward*, and that, in the middle ages, this conception was gradually changed to the reverse, as it is now.

the "discant" in a "plagal" mode.* The idea of *naming* such an accidental combination of tones had not occurred to anybody at that time; it was foreign to the whole spirit of the time. No one of the combined melodies was looked on as predominant, nor was a bass considered as a foundation or support for the others; but all were regarded as equally important individual melodies, and were invariably thus treated. The first half of the 16th century is, in fact, the period in which the imitative contrapuntal style culminated; the second half of the century brings us to the advances made by Palestrina and Orlandus Lassus, and its end to the beginnings of monophony. It is impossible to avoid the idea that the new conception of the *chord*, which came just at this time, and the new way of looking at polyphonic music which resulted from it, must have had a marked effect on musical production.

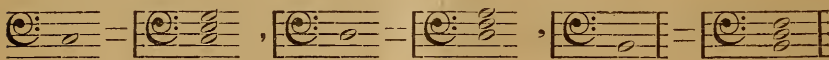
The thoroughbass system was, as I have just shown, the first attempt at indicating chords, and its adoption marked a long step forward, both in the progress of theoretical knowledge and of the practical art of writing. The essential character of thoroughbass is generally well known. It indicates each tone by the number which shows its distance above the bass note, in diatonic degrees. But intervals above an octave are reduced to the lower octave, thus identifying notes an octave apart; with this restriction, however, that their relation to the bass note must remain unchanged. As the intervals are always counted from the bass note, there is no possible way of expressing the fact that the fifth c–g and the fourth g–c are not exactly the same interval. Thus, for example, the following chords are indicated in exactly the same way in the thoroughbass system:—

* A "discant" was simply a second melody invented to go with a given bass and heard simultaneously with it.—TRANSLATOR.

Thus, since the inversions of the intervals of the upper voices are of no consequence so far as the figured bass is concerned, there is no possible way of indicating what interval any given voice makes with the bass. It cannot be denied that the thoroughbass system is an imperfect means of representing harmonies theoretically; but it was the first that was found, and was, for that reason extremely useful.

It was not long before a great many abbreviations came into practical use, which made it much easier to think harmony. It was soon noticed that the chord formed out of a third and a fifth occurred much more frequently than any others. It then became customary to consider this chord as demanded, unless some other figures were written. This chord thus acquired special importance. Only when the third or fifth had to be altered by means of a sharp, flat or natural, was any figure required.

But no distinction was made between a major, minor or diminished chord:—



Thus, the figured-bass system became the means of directing the development of the theory and practice of harmony into quite other channels than those marked out by Zarlino, the most learned and distinguished theorist of his time. The diametrically opposite character of the major and minor chord was totally forgotten. Then, too, Zarlino's treatment of chords makes it perfectly clear that all combinations of the tones c, e and g are, for harmonic purposes, the same chord; and the same is true of all positions and inversions of every major or minor chord. But it was impossible to attain this idea from the standpoint of thoroughbass; indeed, this idea of Zarlino's was pushed more and more into the background, for the thoroughbass system conceived polyphony as *a web of melodies* rather than *a succession of chords.* From the standpoint of thoroughbass, *a minor chord is no different from a major chord, but an inversion of a major chord is a totally different thing from* *the same chord in its fundamental position.* The ideas of Zarlino as to the essential difference between major and minor chords, and the essential unity of any given chord, no matter what its inversion or distribution, were strangled in their birth. The one positive gain was the possibility of indicating all combinations of tones by abbreviations; as, the chord of the sixth by 6; the chord of the sixth and fourth by $\frac{6}{4}$; the chord of the seventh by 7; the chord of the sixth and fifth by $\frac{6}{5}$, etc. That the chord of the sixth is an inversion of the common chord, and that of the sixth and fifth an inversion of the chord of the seventh, was not noticed by anybody till 150 years later. Zarlino's ideas on this matter had, in the meantime, been wholly forgotten.

After the thoroughbass system got into print, as it did, in the works of some Italian composers, toward the year 1600, it spread like wild-fire all over Europe, and soon supplanted the German tablature to a great extent, because the tablature offered no means of naming chords. Reforms and improvements in theory, too, were forced into the background by the rapid rise of the opera, oratorio and instrumental music, and for more than a century thoroughbass had full sway, wherever there was an organ or harpsichord part to be played, whether in church, theatre or concert-hall. The organist or harpsichordist, and for that matter, the player of the theorbo and viol da gamba, had no other written part than a figured bass, from which he was expected to develop a correct polyphonic web of melodies, furnished with melodic ornaments. Thus it will be seen that thoroughbass playing was, till past the middle of the last century, a very important art.

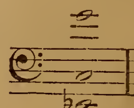
There was no further powerful impulse to a more rational development of theory until 1722, when it came from *Jean Philippe Rameau*,* a man who also occupies a prominent place in the history of French opera. Rameau is to be considered as the man who discovered *overtones*. He observed that a sounding string produced not only its fundamental tone, but the twelfth and seventeenth above it, the fifth above the octave and the major third above the double octave. In other words, he noticed that tones which had been supposed to be simple were really *complex*, made up of several tones; and,

* "Traité d'harmonie reduite à ses principes naturels." Rameau wrote a series of works following out the ideas of this book. The series was completed in 1760.

further, that *these tones are those which form the major chord.* For example, suppose a string produces the tone c, and also its twelfth, g, and seventeenth, e′; we have, then, the major chord of c, thus:

For a musician of Rameau's ability, this discovery was something more than a curiosity, it was a revelation. It is true the phenomenon of overtones was not wholly unknown before Rameau. Mersenne (1636) had called attention to them, and Sauveur (1701) had explained them scientifically, and had emphasized their significance in relation to the understanding of the principles of harmony. But they never became widely known, nor came to any practical importance, as related to the art of music, until Rameau founded his theory of *fundamental basses* on this phenomenon.

Rameau was too good a musician not to know that to deduce the *major* consonant chord only from an acoustic phenomenon was not sufficient to build up a scientific system of harmony. But his attempts to discover a corresponding phenomenon which should account for the *minor* consonant chord, were all in vain. Whether he started out with Zarlino's *mathematical* explanation of the opposite principles of major and minor we do not know. But he did try to find a series of *undertones* corresponding to the *overtones*, to account for the minor chord. He discovered that those strings *of which a given tone is an overtone* (*i. e.*, according to Rameau, the *under* twelfth and seventeenth), will vibrate strongly whenever that string is struck, while others remain silent. He could not distinguish these tones in the mass, but he assumed that they must be there, since the strings were in vibration. So he thought he had discovered in the phenomenon of *sympathetic vibrations* the principle of the *minor chord;* for the *under* twelfth and seventeenth of a note make, with the original note (Rameau's "generator"), a *minor* chord; just as the *over* twelfth and seventeenth make a *major* chord, thus:

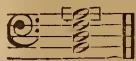


He *had* discovered the true principle, but was, unfortunately, talked out of it by the physicist, D'Alembert, who told him that the lower strings did not vibrate sympathetically in their whole length, so as to give their fundamentals, but only in such fractions as corresponded to the tone of the "generator." We know now that these lower strings *do* vibrate in their whole lengths; although their fundamental tones are much weaker than the partial tones which reinforce and correspond to the tone which generates them. (See my "Musikalische Syntaxis," 1877.)

Thus Rameau had to give up his attempt at a scientific basis for his minor chord, and was forced to build up his system of harmony one-sidedly, on the major principle exclusively. So the minor chord came to be regarded as a modification of the major; as a chord not given in nature; as a less perfect consonance than the major chord. So that, as it finally turned out, his physical explanation of consonance was less satisfactory than Zarlino's mathematical one. There is only one point in which his system really brought musical intelligence a long step forward: he first made it clear that no inversions, transpositions, or changes of distribution of the tones, which make up a consonant chord, alter its harmonic significance in the least; that the tones c, e, g, for example, make the chord of c *and nothing else*, however they may be placed. From the standpoint of thoroughbass, this conception was unattainable, however near it may seem. By thus doing what thoroughbass could never have done, by identifying chords which are made up of the same tones, no matter which of them happens to be in the bass, he invented the theory of *inversions* of chords. That was certainly an extraordinary flash of genius, for it simplified the whole apparatus of harmony at a single stroke. From thenceforth, the common chord, the 6 chord and the $\substack{6\\4}$ chord became simply different forms of the same chord, and the 7, $\substack{6\\5}$, $\substack{6\\4\\3}$ and $\substack{6\\4\\2}$, were similarly identified. This may have been divined before, but it had never been expressed.

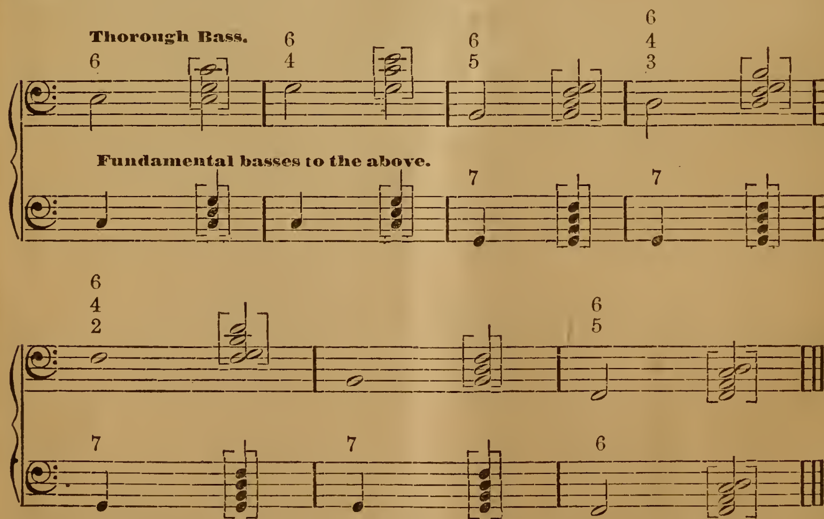
It is very much to be regretted that Rameau was kept back, by d'Alembert, from elaborating his system of harmony on the dual principle. How fine was his harmonic sense is shown by two further peculiarities of his system: (1) By his conceiving the diminished chord as a dominant seventh chord with the root omitted, *e. g.*, B–D–F as the chord with G omitted; and (2) by his conceiving the chord with an added sixth, in C major as the *subdominant* chord and *not* as the first inversion of the supertonic chord with a seventh, as might have been expected, and as is commonly done now. No musician will deny that

the effect of these two chords corresponds to Rameau's explanation. If the g were added to the diminished seventh chord, or the d withdrawn from the other chord, the sense of the harmony would remain the same. Although, indeed, the chord b–d–f might, in some connections, be conceived as the minor seventh chord *below* A, with a omitted.



In both these propositions Rameau divines an idea, to which I shall return, namely that dissonant chords are to be regarded as modifications of consonant chords, never as fundamental forms.

Rameau modified the conception of the thoroughbass system in this: that all *inverted* chords are to be understood *not* in the sense of the *bass-tone*, but as having another tone as root. These roots of inverted chords he called the "fundamental basses." But he retained the practice of reading all chords, whether major or minor, *from below upward.* The following illustration shows the difference between the thoroughbass system and Rameau's "fundamental basses":—



These roots made it possible to comprehend the relations of successive harmonies, and to discover the laws of harmonic succession. Rameau laid down the principle that *the fundamental basses ought to progress only by perfect fifths (or fourths), or in thirds (major or minor).* If this rule hardly suffices for the requirements of modern harmony, it contains, at least, the most important principle of criticism, in that it acknowledges the validity of *third*-relationships equally with the *fifth*-relationships.

Thus it will be seen that Rameau was rich in suggestions pointing toward a rational system of harmony. But the adjective "rational" cannot be applied to his system as a whole. He did, indeed, found the major chord on a rational phenomenon of acoustics, and his derivation of the diminished triad and of the major chord with a major sixth, showed great clearness of perception. But these are isolated phenomena in a scheme which must, in other respects, be characterized as arbitrary. The system itself would remain essentially the same if these ideas were subtracted from it. But that in his system which was really new and peculiar to it was the simplification of the thoroughbass system by his new doctrine of inversions. This doctrine had a direct and permanent influence on the future development of harmony; we find it adopted in the systems of *Calegari*, who died in 1740 ("Trattato del sistema armonico di F. A. Calegari," first published by Balbi in 1829); of *Vallotti* ("Della scienza teorica e pratica della moderna musica," 1779); of *Kirnberger* ("Die Kunst des reinen Satzes," 1774–9); of the *Abbé Vogler* ("Handbuch der Harmonielehre," 1802), and of all succeeding writers. The weak point of Rameau's system, the inconsistency of its relations to acoustic science, was very soon remarked. Vallotti gave up the one-sided attempt to base the major chord on a phenomenon of acoustics, and developed the *diatonic scale* from the higher overtones, among which he found not only the major but the minor chord. D'Alembert, in his "*Eléments de musique théorique et pratique, suivant des principes de M. Rameau,*" (1752), had, in the meantime, pointed out that the overtones noticed by Rameau, viz., the twelfth and the seventeenth, were not the only ones, but only the most prominent of a numerous series, which diminished in power the higher they went. He also called attention to the fact that these overtones corresponded to Zarlino's harmonic divisions of the length of the string producing them; and that, as regards their vibration-numbers, they stood in the ratios of the series of numbers 1, 2, 3, 4, 5, 6, 7, and so on, thus:—

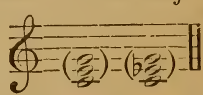
The notes marked with a star are somewhat lower than the corresponding notes of our tempered system.

Vallotti found the scale between the eighth and sixteenth overtones, the major chord in 4 : 5 : 6, and the minor chord in 10 : 12 : 15. But this did not account for the *consonance;* this element consists, according to Rameau, in the fact that we conceive the tones of the chord as *belonging* to the fundamental; g and e′ are consonant with c because they *resolve* or find their point of repose in it. But we cannot conceive e″, g″, b″, as belonging to c without destroying the consonance.

Kirnberger accepted the overtones as an explanation of the major consonant chord; paid no attention to the inconsistency involved in not carrying it out further; gave up Rameau's explanation of the diminished triad and of the major chord with an added sixth, and held to the thoroughbass system of figuring the inversions. He saw no need of any alterations in the system; he regarded the major, minor and diminished triads as equally justified and well-founded, and he accepted, besides, these four kinds of seventh-chords as normal harmonies, viz., major chords with major and minor sevenths, and minor and diminished chords with minor sevenths. Kirnberger's system has maintained itself in practical instruction books, with no essential modifications, to the present day. *Since Rameau, the sole criterion for distinguishing normal chords, inversions and suspensions has been the* FORMATION BY THIRDS; *i. e.*, chords which form a series of thirds above the bass note have been regarded as normal; those which are formed in the same way, but have some other tone than the root in the bass, have been regarded as inversions; and, finally, those which could not be resolved into a series of thirds have been regarded as accidental formations,—as suspensions. This building up of thirds into chords was carried beyond sevenths, to ninths, elevenths and thirteenths, although they had to be used, practically, in elliptical forms. J. H. Knecht, especially, carried these monstrous chords to extremes; but there was soon a reaction from this, and the chord of the ninth became the extreme limit of the chords acknowledged as normal; even this being coupled with certain conditions.

I have already mentioned that Tartini, the renowned violinist, revived Zarlino's idea of the dual nature of harmony, after two hundred years of oblivion.*

It is not impossible that Tartini had thoroughly studied and understood Zarlino; he not only bases the major chord on the harmonic, and the minor chord on the arithmetical division of the string, but he sees in the minor chord *not another kind of third; i. e.* not a *minor* third, as the thoroughbass system does, but only a *changed position of the major third.* In the major chord the major third is *above* the principal tone; in the minor chord it is *below* it; the fifth being here regarded as principal tone, thus:—



But Tartini was a contemporary of Rameau's, and so could not simply occupy Zarlino's standpoint. The question of basing consonance on acoustic principles, which Rameau had raised, excited lively interest in his mind, and he discovered new aspects of it. To be sure, he did not carry the attempt to account for the minor chord beyond pointing out that it is the polar opposite of the major, in the sense of Zarlino's "arithmetical" and "harmonical" division of a string; but he enlarged the conception of the major chord, by refusing to ignore, as other theorists did, the fact that the series of overtones does not stop with the sixth. The seventh overtone (a trifle lower than the seventh of our tempered system) is commonly regarded as a dissonance; but Tartini affirmed, quite consistently, that the major chord with a natural seventh is a *consonance.* This opinion is shared by no less an authority in exact acoustic science than Helmholtz.

As a matter of fact, both are correct, if we take into account only *physical euphony, i. e.* the blending of the tones without disturbance. Indeed, the major chord of our tempered system is less consonant, if this test alone be adopted. But whether even the natural seventh chord, having the proportions 4 : 5 : 6 : 7, is a *musical* consonance or not, is another question.†

* "Trattato di musica secondo la vera scienza dell' armonia," (1754) and "De principj dell' armonia musicale contenuta nel diatonico genere," (1767).

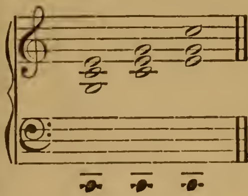
† As to the musical conception of the natural seventh as well as of all the overtones which do not belong to the major chord, see my "Musikalische Logik," (1873, p. 15) and "Musikalische Syntaxis" (1877, p. 7).

2

In such matters Art cannot accept the decisions of Science as final or conclusive. A few decades later than Tartini, Kirnberger and Fasch, in Berlin, also tried to utilize the natural seventh for practical musical purposes, but with small success. For, of course, we can hardly use an *un*tempered seventh with a tempered third and fifth; and nobody has proposed to use the natural seventh in our system as a fundamental (dissonant) interval, without being tempered like the rest.

Tartini is also well known as the discoverer of the *Combination* (or resultant) *tones*, which were named, after him, "The Tartini tones." It is true his "Trattato" was first published in 1754, while Sorge had called attention to the combination-tones in his "Vorgemach musikalischer Komposition," published in 1740; but Tartini discovered them as early as 1714; and when he opened his violin school in Padua, in 1728, he made them the test of the correct intonation of chords. (Compare my "Studien zur Geschichte der Notenschrift," 1878, page 101.) The phenomenon of combination-tones, as Tartini correctly observed, coincides with that of overtones, to this extent. When two tones sound together, the lower (combination) tones which are audible are no other than the tones of the overtone series in which the tones of the original interval would be designated by the smallest ordinal numbers. The series extends downward to the fundamental or generator. Tartini made only an imperfect investigation of the series of combination tones, as did Rameau of the overtones. He only heard the lowest resultant tone, the fundamental tone of the series; and at first (in his "Trattato,") he located it an octave too high; but in his later book "De principj," he gave it its correct position. We know now that the whole overtone series of this fundamental tone can be heard, not only the tones below the given interval, but those which correspond with it, and the higher ones, so that the relationship of the two phenomena is evident enough. The fifth 2 : 3 (c–g) gives only one combination-tone, that which corresponds to 1, namely, the octave below the lower tone of the interval (C). The fourth 3 : 4 (g–c′) makes 1 and 2 (C–c) audible; the third 4 : 5 (c′–e′) the tones 1, 2 and 3 (C–c–g), etc. *These deeper resultant tones are of especial importance in comprehending the major chord; they furnish the only true scientific basis for the explanation of inversions;* since the chord c′–e′–g′, the first inversion (6 chord) e′–g′–c″

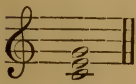
and the second inversion ($^{6}_{4}$ chord), g–c′e′ find their common point of union in the resultant tone C, thus:—



Chords.

Deep resultant tones.

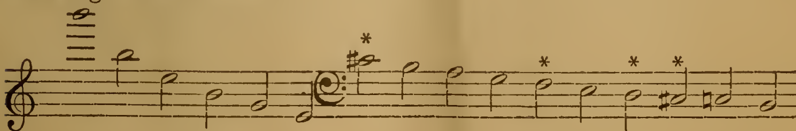
But the typical form of the major



chord is not the close position, but the

open one—

There is another kind of combination (or resultant) tones which did not receive adequate attention until very lately, namely, the *coincident overtones* (A. von Oettingen, Harmonie-system in dualer Entwickelung, 1866). Among the higher tones of an interval or chord (*i. e.*, the overtones of the separate tones of the chord, and the combination-tones of the overtones), *the first common overtone* of the tones of the chord is most distinctly audible. Its ordinal number may be found by multiplying together the ordinal numbers of tones of the intervals in the series of overtones. For this reason it may be called the *multiple-tone.* Thus the major third 4 : 5 (c′-e′) has the multiple tone 4 × 5 = 20 (e‴); the major sixth 3 : 5 (g-e′) has 3 × 5 = 15 (C″); the minor third 5 : 6 (e′-g′) has 5 × 6 = 30 (b‴). As the minor third e′-g′ (or the major sixth g-e′) becomes a major chord by the addition of the *combination-tone* C, so by the addition of the *multiple-tone* b″ (or b‴) either becomes a minor chord. A. von Oettingen (Professor of Physics at the University of Dorpat) sees in the multiple-tone, or, as he calls it, the "phonic overtone," *the natural bond of the minor chord.* Thus b‴ is the common overtone of the following series of tones:—



(The tones marked with a * are all slightly higher than the corresponding tones of the tempered system.)

Here, then, we have the complete *undertone series;* a series of precisely the same fundamental importance as regards the minor chord that the overtone series is as regards the major chord. The tones of this series blend into perfect unity in their relation to the highest tone of the series, exactly as the tones of the overtone series do in relation to their fundamental. How our musical perception deals with those tones of the series which do not belong to the minor chord of e (7, 9, 11, 13, 14, etc.) I have already explained above, in connection with the corresponding tones of the overtone series.

But as we do not account for the major chord by the combination-tones alone, but regard the phenomenon of overtones as the real explanation of it, so, in order to explain the minor chord to our perfect satisfaction, we require a corresponding *phenomenon* of undertones, to set over against the overtones. Although such a phenomenon has not yet been sufficiently well established to be perfectly satisfactory, there are not wanting signs that minor chords are perceived by the mind as sustaining the same relations when reckoned from above downward, that the major chords do when reckoned from below upward. I have already pointed out that the phenomenon of *sympathetic vibrations* gives us the series of undertones. The phenomenon of *jarring* tones belongs to the same category. If a tuning-fork in vibration be set lightly (not firmly) on a sounding board, or if a loosely-fastened metallic plate be set violently vibrating, we hear, *not the fundamental tone* of the plate or fork, but its under octave, under twelfth, even the under double octave, under seventeenth, or other low undertone. But it is indeed probable that every tone *always* generates not only a series of *overtones*, but a series of *undertones* also, decreasing in power in the direct ratio to their depth, and more difficult to detect and separate from the mass of tones in our consciousness than are the overtones. I have diligently collected all possible information on this point, so far as the facts have been observed, and I find nothing inconsistent with this hypothesis. (See my "Musikalische Logik," 1873, p. 12; "Die objective existenz der undertöne in der Schallwelle," 1875, printed separately from the "Allgemeine Deutsche Musikzeitung;" "Musikalische Syntaxis," 1877, preface and appendix, and the article on "Untertöne" in my "Musik-Lexikon.")

But whatever any one may think of this or that opinion of mine, thus much remains certain: *The major and minor chords are, as regards their mathematical and acoustical relations, the polar opposites of each other.* The further question is, whether the physiology of hearing, and the psychology of musical perception find a similar reciprocity of major and minor intelligible, and whether they can recognize this mathematico-physical principle as valid for them also.

The physiology of tone sensations has only lately been thoroughly investigated, mainly by the distinguished physicist and physiologist, Helmholtz.* This book is not devoted exclusively to physiological investigations, as might, perhaps, be inferred from its title, but comprehends the whole domain of exact science as related to tone, from the production and conveyance of tone on to the mental correlation of tone representations. That is to say, it is largely occupied, on the one hand, with mathematical and physical investigation, and on the other, it extends to the field of psychology and æsthetics.

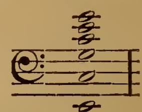
Thus, the theory of overtones and combination-tones is treated in detail, and differences in tone-color (*timbre*) are explained as the result of different combinations of overtones in the complex tones we hear. These investigations are invaluable, especially as regards the theory of the construction of instruments. They explain, for example, the mixture stops of the organ, which were in practical use long before the tones of pipes were known to be complex, showing that the auxiliary ranks of pipes merely reinforce the overtones which make up the chord of the fundamental, and thus strengthen its impression.

The physiological chapters in Helmholtz's book are (1) those which treat of the faculty possessed by the ear of analyzing complex tones, of separating such tones into their component elements, although they reach the ear as a single vibration-form; (2) that which treats of the perception of differences of tone-color (timbre), which rests on the same principles; and (3) that on the comparative euphony of the different kinds of chords. Fine and intelligent as are the investigations and observations on the first two problems, they can only be considered as hypothetical, and Helmholtz himself so considers them. His hypothesis is, that there is in the ear a complicated apparatus of more or less tense nerve fibres of different lengths; that these are set in vibration by sound waves, according to the laws of sympathetic

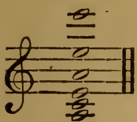
* "Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik" (1863, 4th Auflage, 1877). There is an English translation of this work.—TRANSLATOR.

vibrations, and communicate these to the auditory nerve. The whole apparatus is of microscopic dimensions. This hypothesis has not yet been productive of any positive results as regards the theory of music. Indeed, it is not yet wholly beyond doubt whether it means positive results even in the field of natural science.

But the most vulnerable chapter of Helmholtz's book is that on the nature of consonance and dissonance. These conceptions Helmholtz seeks to explain from the standpoint of physiology, as consisting merely in differences of euphony. He thinks dissonance consists in the presence of "beats," *i. e.*, in the regular and rapid recurrence of reinforcements of tone, producing disturbance. (See Tyndall, on Sound, or any book on Acoustics, Tr.) Consonance he defines as consisting in the absence of beats, or in the reduction of them to a minimum. The major chord is more nearly free from beats than any other; the minor chord has more elements which disturb the consonance from a physiological point of view. Starting with the major chord, as shown in the relations of the first six overtones, which offers fewest disturbances, there can be established a regularly diminishing scale of euphony, measured by the standard of beats, down to the harshest dissonances, and the discords most unavailable for musical purposes. So that, on his principles, neither major and minor consonances nor consonances and dissonances have any other characteristic distinction than a difference of degrees of euphony.



This result is very unsatisfactory, and has already been violently controverted. Professor Arthur von Oettingen especially, in his "Harmonicsystem in dualer Entwickelung" (1866), insisted that there must be a radical difference in principle between major and minor. This difference he found in conceiving the one form of consonance as the polar opposite of the other. That is, he construed the minor consonance as the direct antipode of the other, in the mode already explained; and he carried out this contrast consistently in his doctrine of scales and chords. He pointed out the truth that the minor consonance is not in the least inferior to the major consonance in euphony, when we consider it as resulting from the *under*tone series, just as the major consonance results from the *over*tone series. The minor chord is



just as free from beats as the major chord given above; and blends just as perfectly into a unity, the central point of which is the *highest* tone. There is, to be sure, the common resultant tone F, to disturb the consonance, but over against this we must set the disturbance of the coincident overtone b‴, produced by the major chord in the position given above. Von Oettingen also pointed out a way for the discrimination of consonance and dissonance—a way in which we may reach satisfactory results. But this way leads us from the domain of physiology into that of psychology.

With great intellectual acuteness, the able Göttingen philosopher, Hermann Lotze (Geschichte der Aesthetik in Deutschland, 1868), discovered the Achilles-heel of the Helmholtz system. Like von Oettingen, he insisted on a difference of principle between major and minor, and between consonance and dissonance. He even thought the difference between different kinds of dissonances must be something more than difference in degrees of euphony. Since then a number of musico-theoretical writings have been published, in which those points of Helmholtz's doctrine criticised by von Oettingen and Lotze have been attacked from different standpoints. These writings take von Oettingen's well-nigh complete system as a starting-point for further investigation, and seek to solve those problems which are still doubtful.*

I have thus far said nothing of Moritz Hauptmann, whose epoch-making work, "Die Natur der Harmonik und der Metrik," was published in 1853; but this was because I wished to do full justice to his merits. This I can now do without interruption. Hauptmann was at the same time a man of high musical gifts and a profound philosophic thinker. The idea of *dualism* in harmony, of the diametrically opposite nature of major and minor, which two of the ablest among the older theorists discovered on the line of mathematical construction, he rediscovered on the line of philosophical speculation, long after the works of those two writers, on the dusty shelves of old libraries, were sleeping the sleep of eternal oblivion. Hauptmann's memorable

* Dr. Adolph Thürling's "Die beiden Tongeschlechter und die neuere musikalische Theorie" (1877); Dr. Ottokar Hostinsky's "Die Lehre von den musikalischen Klängen" (1879); and my own "Musikalische Logik," and "Musikalische Syntaxis," as well as my "Skizze einer neuen Methode der Harmoniclehre," (1880).

discovery that the minor chord ought to be regarded as a major chord upside down, developed negatively instead of positively, made a great sensation. Of course, when we now find, in studying the history of harmony teaching, that the same discovery had been made by Tartini a hundred years before and by Zarlino three hundred years earlier, we cannot give Hauptmann the credit of its first discovery; historically it is not a new idea. But it would be very unjust to Hauptmann to deny him the merit of having discovered it for himself. So far as the present and future development of theory is concerned, Hauptmann is the originator of the idea. It did not occur to any of the theorists of our time, any more than to those of the first half of the century, to go back to Zarlino or Tartini for wisdom in these matters. The idea came to all of us from Hauptmann. There are his own faithful pupils, Köhler, Paul, and Rischbieter, who hold to the letter of his teaching. O. Tiersch, who seeks a compromise between Hauptmann and Helmholtz (see his "System und Methode der Harmoniclehre," 1868); then the strictly consistent dualists, von Oettingen, Thürlings, myself, and with some reservations, Hostinsky, who have become more Hauptmannish than Hauptmann himself—all of us received the idea of dualism in harmony as a new conception from him. I myself brought to light the fact that there had been previous advocates of this idea; as regards Tartini, in my pamphlet, "Die objective Existenz, etc.," published in 1875, and as regards Zarlino, in the article "Zarlino als harmonischer Dualist," published in the "Monatshefte für Musikgeschichte," in the year 1881.

Hauptmann's system influenced Helmholtz's very strongly, although he has never accepted the principle of dualism in harmony, and even now maintains, at most, a passive attitude with reference to it. The evidence of this is to be found in Part III of his "Tonempfindungen," on "Chord Affinities." This is the most valuable part of his book, as regards music. In this part one feels everywhere that Hauptmann's fundamental principle—"there are three directly intelligible intervals: I, the Octave; II, the Fifth; III, the Major Third" (Natur der Harmonik und der Metrik, p. 21)—underlies the whole. This is a great and epoch-making conception, and implies everything which exact science has discovered since. Hauptmann makes no account of minor thirds, fourths, sixths, or any other intervals. To his mind, they have no independent existence or significance; they are only products, combinations of the fundamental conceptions, octave, fifth, third. It must be confessed that even this was not absolutely new; mathematicians had known for centuries that all possible musical intervals could be expressed as products and powers of the numbers 2, 3, 5. The ancient theory recognized only two fundamental intervals: the octave and the fifth. All other intervals it derived from these. Thus, the second (c–d) was the second fifth (c–g–d) reduced to the lower octave; the third was a lower octave of the fourth fifth (c–g–d–a–e), etc. Since Fogliani and Zarlino established the consonance of the third, that interval has been taken into account in all occidental music. The major seventh (c–b), for example, is defined as the third of the fifth (c–g–b); the augmented fourth (c–f♯) as the third of the second fifth (c–g–d–f♯); the augmented fifth (c–g♯) as the third of the third, etc. But it was Hauptmann through whom the recognition of these facts passed into the text-books on harmony.

It was Hauptmann who invented a notation (letters, not notes), by means of which he could distinguish tones related by fifths from those related by thirds. In this notation, two tones of the same name, but differing by the so-called "Didymic," or "syntonic comma," were indicated, the one by a capital and the other by a lower-case letter. As above mentioned, Didymus had a tetrachord, $\overset{\text{b.}}{} \underset{\frac{16}{15}}{} \overset{\text{c.}}{} \underset{\frac{10}{9}}{} \overset{\text{d.}}{} \underset{\frac{6}{8}}{} \overset{\text{e,}}{}$ in which there were two kinds of whole-tones, one having the ratio 10 : 9, and the other 9 : 8. The difference of the two ratios ($\frac{10}{9} : \frac{9}{8}$) is the "Didymic comma," 80 : 81.

In our major scale, the whole tone c–d has the ratio 8 : 9, (d is the second fifth of c, *i. e.*, $(\frac{3}{2})^2 = \frac{9}{4}$, reduced to the lower octave, $\frac{9}{8}$), and the whole tone d–e has the ratio of 9 : 10, (e is the third of c; *i. e.*, $\frac{5}{4}$, and d : e $= \frac{9}{8} : \frac{5}{4} = \frac{40}{36} = \frac{10}{9}$. This third e ($\frac{5}{4}$) differs from the e which is a lower octave of the fourth fifth by 80 : 81. For the fourth fifth (c–g–d–a–e) $= (\frac{3}{2})^4 = \frac{81}{16}$; reduced to the lower octave, $\frac{81}{64}$. The true third, $\frac{5}{4} = \frac{80}{64}$. Ratio of the two thirds, 80 : 81. Hauptmann uses a capital C for the note which was his original starting point; the true third he indicates with a small e, and uses a capital E for the tone produced from the series of fifths. Everywhere in his notation capital letters indicate a series of fifths; intervals represented by large and small letters alternately are thirds; those represented by small letters form a series of fifths with one another, thus:—

a	e	b	f♯	c♯	g♯	d♯
F	C	G	D	A	E	B
d♭	a♭	e♭	b♭	f	c	g.

Hauptmann represents the key as made up of the three chords, Tonic, Dominant, and Subdominant, thus:—

F a C e G b D

Here we have the two series of fifths, F–C–G–D and a–e–b; the one made up of tones related to c by fifths, and the other by thirds. The most important point in this treatment of the subject is the recognition of *third-relationship* in tones and in keys. Even Marx wondered that the keys of E major and A major are directly intelligible after C major, while D major and B♭ major sound foreign and unrelated after it. Marx knew nothing of third-relationship, and was naturally astonished that the key of the fourth fifth in the series should seem more closely related than that of the second fifth. But e major is not the key of the fourth fifth, but the key of the third. Although Beethoven, in his sonata in C, Op. 53, wrote his second subject in E major (first movement), Hauptmann was the first who clearly pointed out the third-relationship of keys, and thus solved the problem once for all. Since that time the idea of the third-relationship of keys as equally valid with the fifth-relationships has got itself fairly established in the later music; although many theorists, of the sort who hold rigidly to ancient traditions and are impervious to such discoveries of genius as this of Hauptmann's, still look on it as something abnormal, or, at best, barely allowable.

Hauptmann's letter notation distinguishing the third-related from the fifth-related tones has been improved by Helmholtz and von Oettingen so as to distinguish underthirds and overthirds; thirds related in the first from those related in the second degree, and so on, thus:—

$$\underline{\underline{c\sharp}}\quad \underline{\underline{g\sharp}}\quad \underline{\underline{d\sharp}}\ \text{etc.}$$

$$\ldots\ \underline{f}\quad \underline{c}\quad \underline{g}\quad \underline{d}\quad \underline{a}\quad \underline{e}\quad \underline{b}\quad \underline{f\sharp}\quad \underline{c\sharp}\quad \underline{g\sharp}\quad \underline{d\sharp}\ \ldots$$

$$\ldots\ d\flat\quad a\flat\quad e\flat\quad b\flat\quad f\quad c\quad g\quad d\quad a\quad e\quad b\quad f\sharp\quad c\sharp\quad g\sharp\quad d\sharp\ \ldots$$

$$\ldots\ \overline{d\flat}\quad \overline{a\flat}\quad \overline{e\flat}\quad \overline{b\flat}\quad \overline{f}\quad \overline{c}\quad \overline{g}\quad \overline{d}\quad \overline{a}\quad \overline{e}\quad \overline{b}\ \ldots$$

$$\ldots\ \overline{\overline{b\flat\flat}}\quad \overline{\overline{f\flat}}\ \text{etc.}$$

Instead of using large and small letters, the mark — is invariably used to indicate the comma (80 : 81). Thus $\underline{e}$ is a comma lower than e; $\overline{a\flat}$ is a comma higher than a♭; $\underline{\underline{c\sharp}}$ is two commas lower than c♯, etc.

But Helmholtz not only grasped Hauptmann's theory in all its comprehensiveness and placed it on a scientific basis (leaving out of sight his unsatisfactory explanation of the minor chord and of the difference between consonance and dissonance), but he developed it further by a new conception, that of *chord substitution*, a conception which has opened wholly new perspectives. All theorists may have divined that we conceive of single tones as substitutes or representatives of chords, but no one else had ever said so. With Helmholtz, all complex tones are overtone combinations, *i. e.* major chords. The minor chord c–e♭–g, he conceived as a compound of two major chords, those of c and e♭. Hostinsky follows him in this and even goes further. But von Oettingen has widened the range of this conception of Helmholtz to an unexampled degree, by treating the minor chord as a real chord which may be represented in the mind when only one of its tones is present. In this view, the principle of chord substitution (or representation in the above sense) is no longer a principle of acoustics or Physiology but of Psychology. If we really find by experience that we are able to conceive a tone as representing a minor chord just as easily as a major chord, neither chord being audibly present, then that is a scientific fact on which we may build quite as well as we can on acoustic phenomena. When we have once acknowledged this, it seems of very little account whether the minor chord can be based on acoustic facts or not. The psychological fact that we conceive single tones in the sense of chords remains. We can imagine any given tone as representing three major and three minor chords; we can think of it as principal tone, third or fifth of either a major or minor chord. It is no more difficult for us to imagine a given e, for example, as principal tone of its under-chord (a–c–e), or as under-fifth of the under-chord of f (e–g–b),or as third of the under-chord of g♯ (c–e–g♯), than it is to imagine it as root of its over-chord (e–g♯–b) or as fifth of an over-chord (a–c♯–e) or as third of c over-chord, (c–e–g). There are no other chords for which we can use the tone e as a substitute or representative in imagination. Whereever else it occurs, it must be a dissonant, disturbing element; *e. g.* as seventh in the chord of f♯ major, as an added sixth to the chord of g major, etc.

This latest advance in scientific knowledge has transformed the science of Harmony from a doctrine of the mathematical relations of musical intervals to a doctrine of mental tone-representations and their connections. Acoustics and the physiology of hearing are remanded to their proper place of auxiliary sciences, the place which belongs to them, and which they have always occupied in the estimation of musicians. It is a revolution which the musician is glad to see, for he is familiar with mental representations of tones and chords, and he instantly comprehends a theory based on them, as soon as its terminology is familiar; while he feels a great gulf fixed between the calculations of the physicist, or the nerve affections of the physiologist on the one hand, and his musical conceptions on the other. This very gulf separates Parts II and III of Helmholtz's "Lehre von der Tonempfindungen." Part III is clear and lucid, full of genuine musical intelligence; Part II strives in vain to connect itself with real music, and its sole result is the above mentioned imperfect explanation of consonance and dissonance.

The mistake which Helmholtz made, is now easy to recognize. He tried to explain from the nature of sounding bodies conceptions which can only be explained from the nature of the perceiving mind. Consonance and dissonance are *musical* conceptions—not definite forms of sound-waves. But it must not be forgotten that the recognition of this truth was only possible after long-continued investigations in physics and physiology. It was necessary first to make clear that physics and physiology could never suffice as a foundation for musical conceptions, before psychology could take its rightful place. We know now that there are no *absolute* consonances; that a combination of tones acoustically and physiologically free from disturbing elements, may nevertheless be a *dissonance*, musically speaking. The $^6_4$ chord is an example.

Lest I extend this sketch beyond reasonable limits, I must be brief now, and can only indicate in outline the form impressed on the doctrine of Harmony by the conception of chord substitution.

As long as a tone seems to have no definite relation to a chord, we have in the mind only the simple representation of a single tone; the idea is empty and unsatisfactory; it embraces at most only the lower and upper octaves of the single tones in addition to it. But we very seldom think tones in this unrelated way. When a piece begins with a single tone, we are apt to think of it as principal tone of a chord, either major or minor. But the harmonic sense of an *interval* is much more definite. A single tone may be conceived of as occupying any one of six different relations; but a consonant interval can only be thought in *two*. Thus c–g must be conceived as representing either c over-chord or g under-chord. It cannot belong to any other consonant chord; and we do not naturally conceive it as a dissonance unless some tone or tones are added which belong to a different chord.

But even the idea of a consonant chord is not *final*, but is capable of further definition. If we imagine the chord of C major, as belonging in the key of F major, or G major, or C major, the chord is conceived differently in each case. Helmholtz rightly observed (Tonempfindungen, 4th edition, p. 471) that a chord, in order to close a piece satisfactorily, must be not merely a *consonant* chord, but the *tonic* chord. But when Helmholtz goes on to say that former theorists have not been perfectly clear on this point, I must except Tartini, who, in his *Trattato* (p. 112), insists that all the tones of a key are dissonances except those which belong to the tonic chord. In other words, *the only consonant chord* in any key, in the strictest sense of the term, *is the tonic chord*. That is, the tonic is the only chord which can be used for the final point of repose; the only one which does not distinctly require a further progression. In c major, it is the chord c–e–g; in g major, g–b–d; in a minor, a–c–e, etc. In c major, the chord of g is not a perfect consonance; as is proved by this fact alone, viz., that the seventh, f, can be added to it without any essential change in its harmonic significance, or even of its acoustic relations. Nor is the chord of F major a true consonance in the key of C; and a major sixth (d) may be added to it without any essentiai change in the mental effect. The effect of these chords is *dissonance-like;* or better, the perception of them contains something which disturbs their consonance; and this something is simply their *relation* to the chord of C major. For to think a chord in the sense of a certain key is to understand it as related to another chord; just as to think a tone in the sense of a certain chord is to conceive it not as isolated, but as related to a principal tone, or as principal tone itself in its relation to the others. When I imagine the chord of c major as in the *key* of c major, then it is itself tonic, centre, point of repose; the idea of it involves nothing contradictory, nor any element which disturbs its consonance; it is simple, pure, reposeful. But when I imagine the chord of g major as in the key of c, then I think of it as the chord of the over-fifth of the chord of c; that is to say, *the chord of c major forms a part of the conception,* as being the chord which determines the significance of the chord of g—the chord from which the g chord is distinguished, and to which it is related. The central point of the idea, so to speak, *lies outside* of the chord of g; there is in that chord an element of unrest; we feel it necessary to go on to the chord of c as the only satisfactory point of repose. This element of dissatisfaction constitutes dissonance.

It is just so with the chord of F major, and with every other chord of the key. This modern conception of key, or *tonality,* as we have come to call it, to distinguish it from the old idea of key, is not confined to the scale. We can imagine chords containing tones outside of the scale as being intimately related to the tonic chord. This is especially true of the (major) chords of the major third above and below the tonic (in c major, the chords of e major and a♭ major), and also of the minor third above and below (in C major, e♭ major and a major).

The idea of tone relationship may be extended to the relation of keys to one another. As the principal tone of a chord is related to its accessory tones (the third and fifth, and more distantly related tones), and as the tonic chord in a key is related to the accessory chords (chords of the fifths, thirds, etc.), so the principal key of a piece is related to the accessory keys which occur in it (the key of the fifth above and below, the third above and below, etc.). In a piece in c major, the *key* of g major plays much the same part that a *chord* of g major does in a short cadence in the key of c, or that the tone of g does in an arpeggio on the chord of c, or that the tones b and d do in the scale of c. That is, the effect in all these cases is *dissonant;* it has no justification in itself, independent of its relation to something else; its justification is *conditioned,* and it can lay no claim to permanent duration.

Thus the fundamental laws of chord-succession, as well as of the succession of keys (Modulation) may be deduced directly from the extension of these simplest musical conceptions, consonance and dissonance. Psychology teaches us that different conceptions cannot maintain themselves at the same time in consciousness on a footing of equality; one must dominate, and the others will seem to contradict or disturb it. This doctrine proves true in the fullest sense in the case of musical ideas; it furnishes the data for a true definition of consonance and dissonance, such as the physicists and physiologists in vain attempt to formulate. By means of it we discover not only the difference in principle between consonance and dissonance, but also the qualitative difference between the different kinds of dissonances which Lotze demanded.

Consonance is the perception of unity in the relation of the tones which make up a chord. Dissonance is the perception of want of unity in the chord; of the presence of elements belonging to other chords which disturb the unity, which contradict the main sense of the chord. The two or more chords which are always represented in a dissonant chord are not *coördinate* in it, but one of them is chief, and the rest modify it. This modification will differ, of course, according to the various relations of the chords represented.

The experience of centuries has established that the tonic chord in a key can only be a major or a minor chord. This we may easily confirm at any time by psychological experiment, and must, therefore, regard it as a natural law. No diminished chord, chord of the seventh, or any kind of dissonance can possibly serve as principal chord of a key. It is strange, therefore, that theorists did not long ago arrive at the conclusion that dissonant chords are *never intelligible in and of themselves,* but must always be understood *in the* *sense of a consonance.* This is true whether the dissonance consists in adding a dissonant tone to a consonant chord, as in chords of the seventh, sixth and ninth; in the substitution for a tone belonging to the chord, of a foreign tone which leads to it, as in the case of suspensions; or in the chromatic alteration of a note of a chord, for the purpose of leading up to a tone of the succeeding chord (altered chords). Instead of looking upon discords as mere modifications of concords, theorists to this day regard discords as independent chord formations, equally well founded and justifiable with the major and minor concords. The blame for this belongs to Kirnberger, who failed to understand and carry out Rameau's notions as to discords being derived from concords, and stuck to the old chord classification of the thoroughbass system, which could not possibly be accommodated to the needs of progress in harmonic intelligence.

If the theory of harmony, which I have here sketched, should ever be fully worked out into a complete system, then the study of harmony will become a real exercise in music-thinking. The simple will, of itself, point the way to the more complex, and will stimulate the learner boldly to venture on the new, rather than, as heretofore, to *seek* the new. In my "Musical Syntax," and my "Sketch of a New Method of Teaching Harmony," I have attempted a detailed system. Especially in the former, I have tried to establish comprehensive points of view for the construction of complete harmonic wholes. But in closing I wish to emphasize once more, that however much may be found new in the external apparatus of my presentation, in machinery or treatment, the leading points of view, the fundamental ideas, are not to be credited to me. So far as they cannot be referred back to older theorists, especially to Rameau, they belong to the three greatest promoters of intelligence, as regards the essential nature of harmony: Moritz Hauptmann, Heinrich Helmholtz and Arthur von Oettingen.

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