Rhythm as Form of Physiological Process (part 2)

- Recherches
- Le rythme dans les sciences et les arts contemporains
- Psychologie - Nouvel article
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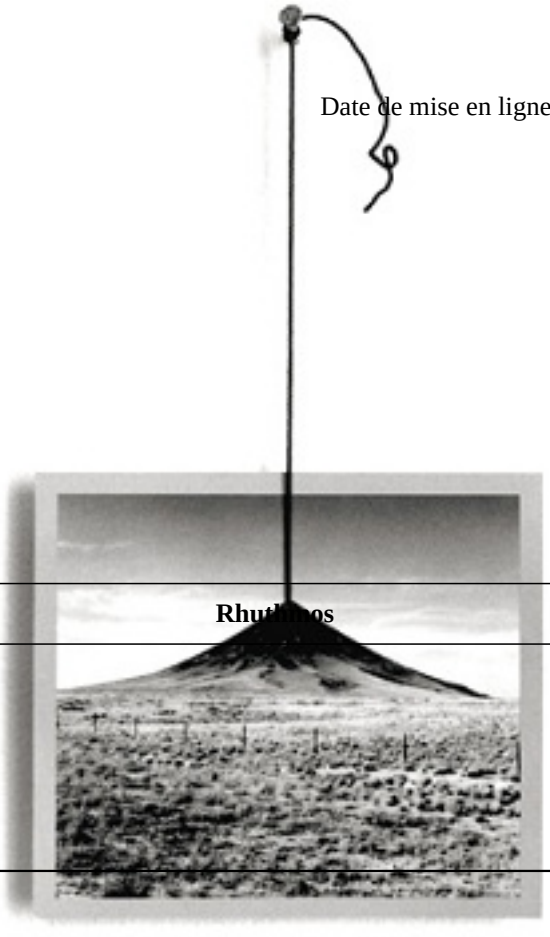
Date de mise en ligne : Thursday 28 June 2018



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Physiology of Musical Rhythm (Helmholtz - 1863-1870)

In 1863, the German physicist, physiologist, and psychologist Hermann von Helmholtz (1821-1894) published *Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik - On the Sensations of Tone as Physiological Basis for the Theory of Music*, which was foundational for the theory of sound perception, especially in music. It was republished five times (last Germ. ed. 1896) and translated into English from the 1870 German edition as soon as 1875 (last Engl. ed. 1912).

Before analyzing this contribution, it is worth noticing that, as expected given the most common opinion among musicians as well as theoreticians in his time, rhythm was not of a great concern to Helmholtz, who mainly concentrated on melody and harmony. Only a very few pages were directly dedicated to rhythm, which was not even mentioned in the first definition of music given in the preface to the third German edition (1870).

> The essential basis of Music is *Melody*. Harmony has become to Western Europeans during the last three centuries an essential, and, to our present taste, indispensable means of strengthening melodic relations, but finely developed music existed for thousands of years and still exists in ultra-European nations, without any harmony at all. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. xiv-xv)

Secondly, in the first part of the book in which Helmholtz presented the result of his experimental investigations in the acoustics and physiology of hearing i.e. the physical and biological parts he never used the term rhythm. As it began to be customary in his time in medicine and physiology (see vol. 2, chap. 2), he used instead "vibrations," "undulations," or "waves." Rhythm appeared still in a very limited way only in the last part, where Helmholtz discussed the psychological and aesthetic aspects of music.

Helmholtz first recalled the origin of measured music in the West from the end of the 11th century. Measured music developed, he recalled, from the need to "adapt to one another by slight changes in rhythm or pitch" two different melodies.

The first undoubted form of part-music intentionally for several voices, was the so-called *discantus*, which became known at the end of the eleventh century in France and Flanders. The oldest specimens of this kind of music which have been preserved are of the following description. Two entirely different melodies and to all appearance the more different the better were adapted to one another by slight changes in rhythm or pitch *[durch kleine Veränderungen des Rhythmus oder der Tonhöhen]*, until they formed a tolerably consonant whole. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 373-374)

What Helmholtz meant here by rhythm was made clear a few line below. Since "there was no division of time in the Gregorian *Cantus firmus*" i.e. the pre-existing melody forming the basis of polyphonic composition and since each one of an ever growing number of singers was singing a different part around the *cantus firmus*, "time *[Takt]* had to be strictly observed." Rhythm was clearly synonymous with regular measure.

> To keep the various parts together, time had to be strictly observed *[war strenges Einhalten des Taktes nöthig]*, and hence the influence of discant developed a system of musical [rhythmic] *[das System der musikalischen Rhythmik]*, which again contributed to infuse greater power and importance into melodic progression. There was no division of time *[keine Takteinheilung]* in the Gregorian *Cantus firmus*. The rhythm of dance music *[die Rhythmik der Tanzmusik]* was probably extremely simple. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 374, my mod.)

Although Helmholtz knew of the existence of unmeasured musics in the West, as in other cultures, he thought that "psychological reason," i.e. what he saw as the "natural progress of the human spirit," led "to rhythmic subdivision periodically repeated" exactly as "*alterations of pitch in melodies take place by intervals, and not by continuous transitions*." Rhythm was to duration as melody to pitch and therefore based on the same kind of periodic distribution according to proportions.

> The first fact that we meet with in the music of all nations, so far as is yet known, is that *alterations of pitch in melodies take place by intervals, and not by continuous transitions*. The psychological reason of this fact would seem to be the same as that which led to rhythmic subdivision periodically repeated *[welcher zur Abtheilung rhythmisch sich wiederholender Taktabschnitte genöthigt hat]*. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 386, Helmholtz's italics)

Alluding to Pythagoras, Plato and the long series of their followers, Helmholtz equated rhythm and pitch scale, both being ways to "measure [the] progression," either in time or pitch, of the sound flow.

> The musical scale is as it were the divided rod, by which we measure progression in pitch, as rhythm measures progression in time. Hence the analogy between the scale of tones and rhythm naturally occurred to musical theoreticians of ancient as well as modern times. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 389)

Discussing the effect of music on the mind, Helmholtz, using a comparison that was to become pervasive in the whole German culture at the end of the 19th and the beginning of the 20th centuries, compared it to the effect of running waters or better yet, sea waves. Contrary to a quiet sea or the smooth undulations of a body of water, only rolling waves would please, he said, the human mind because they produce "a peculiar feeling of pleasant repose or weariness, and the impression of a mighty orderly life, finely linked together."

Not merely music but even other kinds of motions may produce similar effects. Water in motion, as in cascades or sea waves *[im Wogen des Meeres]*, has an effect in some respects similar to music. How long and how often can we sit and look at the waves rolling in to the shore *[den anlaufenden Wogen zusehen]*! Their rhythmic motion *[Ihre rhythmische Bewegung]*, perpetually varied in detail, produces a peculiar feeling of pleasant repose or weariness, and the impression of a mighty orderly life, finely linked together. When the sea is quiet and smooth we can enjoy its colouring for a while, but it gives no such lasting pleasure as the rolling waves *[als wenn sie wogt]*. Small undulations, on the other hand, on small surfaces of water, follow one another to rapidly, and disturb rather than please. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 386)

Yet, since the pleasure was maximum when the music was "easily, clearly, and certainly" perceived, it necessitated "the steps of this motion, their rapidity and amount [be] exactly measurable by immediate perception."

> As we have seen, then, melody has to express the motion, in such a manner that the hearer easily, clearly, and certainly appreciates the character of that motion by *immediate perception*. This is only possible when the steps of this motion *[die Schritte dieser Bewegung]*, their rapidity and amount are exactly *measurable* by immediate perception. Melodic motion is change of pitch in time. To measure it perfectly, the length of the time elapsed, and the distance between the pitches, must be measurable. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 387)

In turn, measurability implied "regularity" and "determinate" distribution. Musical rhythm was thus based on "the recurrence of similar events" analogous to "the revolution of the earth or moon, or the swing of a pendulum."

> This is possible for immediate audition only on condition that the alterations both in time and pitch should proceed by regular and determinate degrees *[in regelmässigen und fest bestimmten Stufen]*. This is immediately clear for time, for scientific just like other measurement of time depend on the rhythmical recurrence of similar events *[auf der rhythmischen Wiederkehr gleicher Ereignisse]*, the revolution of the earth or moon, or the swing of a pendulum *[auf dem Umlauf der Erde, des Mondes, den Schwingungen des Pendels]*. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 387-388)

The primacy of the musical model and, in music, of melody at the expense of rhythm, explains why, concerning poetry, Helmholtz finally assumed the most traditional metric conception and, just as his contemporary Brücke, bluntly reduced poetic rhythm to "the regular alternation of accentuated and unaccentuated sounds" that would provide "artistic order" to the naturally rugged linguistic expression, while, as for Schopenhauer and many others, musical rhythm would, as expected, reach "the inmost nature" of the soul.

> Thus also the regular alternation of accentuated and unaccentuated sounds *[durch den regelmässigen Wechsel accentuirter und nicht accentuirter Laute]* in music and poetry gives the measure of time for the composition. But whereas in poetry the construction of the verse serves only to reduce the external accidents of linguistic expression to artistic order; in music, rhythm, as the measure of time, belongs to the inmost nature of expression. Hence also a much more delicate and elaborate development of rhythm was required in music than in verse. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 388)

Since poetry was, Helmholtz claimed, only about producing "images" which could stimulate "imagination and memory," sound and rhythm were actually of secondary importance in it.

> *Poetry* aims most distinctly at merely exciting the formation of images, by addressing itself especially to imagination and memory, and it is only by subordinate auxiliaries of a more musical description, such as rhythm, and imitations of sounds, that it appeals to the immediate sensation of hearing. (*On the Sensations of Tone*, trans. Alexander J. Ellis, p. 3)

Helmholtz's contribution to rhythmology was thus paradoxical. On the one hand, he held an openly materialist position, severely criticizing any vitalist contention and any metaphysical presupposition; he also accurately disapproved of the wide separation between "the horizons of physics, philosophy, and art" (p. 1). But on the other hand, he not only ignored the Ancient Materialists' as well as Aristotle's poetic contributions concerning the concept of *rhuthmos* (see vol. 1, chap. 1 and 3), which were ill-known in his days, but also, which is more disturbing, those of Diderot, even some of the German Romantics and, most disconcerting, the most insightful artists of his own time (see vol. 2, part. 2 and 4), who could have been of great help to him. Instead, he conceived of rhythm as a matter of fact as most of his fellow materialist scientists on a sheer Platonic basis (see vol. 1, chap. 1 and 2).

While rhythm appeared as a mere result of the human sensory process rhythmic measurability was required by the physics and physiology of human nature it was still metrically defined as "order of movement." Moreover, it was equated, beyond small-scale changes, with a periodic recurrence of beats or stresses a claim which induced Helmholtz to reinstate the traditional cosmic trend of rhythmology (see vol. 2, chap. 1). Through perception, the human mind could feel her link to the well-ordered Universe, which had periodic rhythm of its own. Although they were initially meant to be part of a materialist worldview, this exclusive attention to regular patterns and this cosmic trend of thought were soon to be appropriated and changed into a war machine against materialism by neo-Romantics as Ludwig Klages.

Physiology of Poetic Rhythm (Brücke - 1871)

As Hermann von Helmholtz, Carl Ludwig, and Emil Du Bois-Reymond, the German-Austrian physiologist Ernst Wilhelm von Brücke (1819-1892) was a resolute advocate of the School of Organic Physics which wanted to practice physiology exclusively on the basis of the exact natural sciences and in decided contrast to the so-called "Romantic Physiology" or to older vitalist currents. Contrarily to his colleagues, though, Brücke paid some heed to poetry. In 1871, he published a short booklet comprising 81 pages entitled *Die physiologischen Grundlagen der neuhochdeutschen Verskunst - The Physiological Bases of the New High German Prosody*.

Brücke was very critical about the metric theory of the first half of the 19th century which, due to a forced translation of metric patterns from tongues as Greek and Latin based on syllable quantity to German based on word stresses, tended to impose an unnatural pronunciation either by displacing word accents or distorting syllable durations.

> I do not think the reader will contradict me if I proceed from the principle that a verse is all the more correct, the less one must depart from the prosaic pronunciation while scanning it *[scandiren]*. If one wants to prove a prosodic error, one only needs to scan *[scandiren]* it sharply and show the distortion which the pronunciation of one or the other word or group of words suffers as a result. This distortion can essentially be of two kinds: first, it can affect the accent, and second, the quantity. It is therefore possible to distinguish two fundamental laws, the law of accent congruence, which states that the accentuation required by the verse should not diverge from the common one; and the law of duration congruence, which states that we should not be compelled by the verse structure to time the pronunciation of the individual syllables in such a way that disturbing deviations from the natural and recognized as correct use arise. We must devote a special investigation to each of these two laws. (*The Physiological Bases of the New High German Prosody*, p. 1, my trans.)

Brücke wanted to expose a more "natural" way to deliver German poetry by retrieving the physiological bases of the

German language. It was clearly a naturalist enterprise which was attuned with those of his colleagues in the school of Organic Physics.

But he encountered the same paradox as them. On the one hand, Brücke made remarkable findings. He underlined the fact that the metric patterns based on ictuses could sometimes conflict with the natural stresses of the German language and artificially transform an unstressed syllable in a stressed one. This could even result in " inadmissible and ridiculous" way of scanning a line of verse (p. 21).

> It is clear from the above that one will first choose stressed syllables to place ictuses, but also that arses which are not hit by an ictus may support a second-order stress. The fact that it too is formed of a stressed syllable does not cause any distortion of the accent, but rather that the ictus falls on a weaker syllable. If we scan *[Scandiren wir]*:
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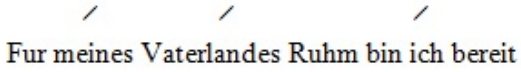
> 
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> we read according to the usual scheme for the iambic trimeter, but we read badly. In order to make the verse lecture bearable, we are compelled to change its rhythm *[den Rhythmus desselben]* and read.
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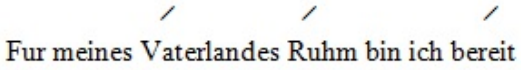
> 
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> Here is a new rhythm *[ein neuer Rhythmus]* given by three equidistant ictuses, only with the difference that the ictus does not fall on the first but on the second arsis of each dipody. (*The Physiological Bases of the New High German Prosody*, p. 5-6, my trans.)

He, therefore, found necessary to adapt the metric accents to the most common pronunciation of word stresses.

> The change of rhythm *[Der Wechsel des Rhythmus]* in one and the same system of versification is not only permissible, but often even required. (*The Physiological Bases of the New High German Prosody*, p. 6, my trans.)

He laudatorily quoted Minckwitz's *Lehrbuch der deutschen Verskunst* (1863, p. 22 and p. 87) for making it clear that German poetry could not, for sheer linguistic reasons, indiscriminately use Ancient Greek patterns yet, eventually criticizing him for being in other passages inconsistent with his previous statements (p. 11).

> The main accents of the verse, namely its ictuses *[Hebungen]*, must not be placed on any other syllables than on those which have the main accent of High German pronunciation. The observation of this law produces rhythms *[Rhythmen]* which must appear most pertinent and appropriate even to the one who does not know anything about verse and versification, or for the first time hears a series of feet. [...] An artificial rhythm *[ein künstlicher Rhythmus]*, built solely on musical sound as in Greek, was not possible in our language because the logical accentuation of words *[die logische Betonung der Wörter]* could not be changed but had to remain the same as in prose. (Minckwitz quoted in *The Physiological Bases of the New High German Prosody*, p. 11-12, my trans.)

But on the other hand, he defined, according to a metric, Platonic and a rather narrow definition respectively to already existing alternatives (see, vol. 2, sect. 2 and 4) verse rhythm as a succession of "accents" and "ictuses."

> It is well-known that the individual syllabic complexes on which the verse is built, the so-called verse feet, are composed of a raising of the voice *(arsis)*, that is, an intensified exhalation pressure, and a lowering of the voice *(thesis)*, i.e. a diminished expiratory pressure. But just as there is accent of the first order and accent of the second order, not every arsis is equal to the others; in many cases one has to distinguish first order arses and second order ones. The former are the ones who are said to be hit by the ictus. Thus, in regular and complete iambic trimeter, the ictus falls on the first arsis of each dipody [group of two feet], and we therefore scan *[wir scandiren deshalb]*:
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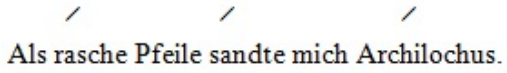
> 
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> (*The Physiological Bases of the New High German Prosody*, p. 5, my trans.)

The paradoxical association of a correct perception of German poetry with a Platonic perspective explains why Brücke's main contribution to rhythmology concerned the measurement of the metric durations between arses and ictuses in verse.

> Since we are dealing with the metric as theory of time measurement *[als der Lehre von der Zeitmessung]*, let us simply ask ourselves: what is the basis of our measurement *[unseres Messens]* in each individual case, the length *[die Länge]*, which, on the one hand, we may not surpass, but, on the other hand, must be fully realized? If we recite [Man recitire] any verse and simultaneously beat time *[schlage den Tact dazu]*, it will be easy to perceive that the latter always corresponds with the uplift. Time beating is here, as in music, nothing but a tool for time measurement. The regular, or at least to a certain extent, regulated distances from arsis to arsis are therefore the basis of our whole time measurement, and this is confirmed by the experience of reciting verse *[das Sprechen von Versen]* while playing music or dancing. (*The Physiological Bases of the New High German Prosody*, p. 22, my trans.)

For the sake of scientific objectivity and precision, Brücke used a kimograph dubbed with a metronome to measure the time distances between arses and ictuses.

> For these measurements, I made use of a kymograph-drum, rotating at a steady speed, on which I marked each arsis, including those struck by an ictus, while reciting [recitirte] iambic verses, hexameters, alcaic and sapphic stanzas. At the same time, the signals of a metronome were electrically transmitted to the same drum in order to inform the observer of any changes in the course of the instrument. (*The Physiological Bases of the New High German Prosody*, p. 23, see also p. 31, my trans.)

Predictably, he found that the distances between the various stresses were approximately equal to each other.

> The subsequent comparison of the time distances between the individual marks showed that in iambic and trochaic meter the arses hit by an ictus and those not hit were equally distributed, and further that in the hexameter, in the alcaic and sapphic verses all arses were at the same distance. (*The Physiological Bases of the New High German Prosody*, p. 23, my trans.)

Another important contribution was Brücke's measurement of syllable durations and the study of their varying associations by linking the kimograph to the lips.

> Finally, in order to completely eliminate the influence of the various vowels and consonants, [and] so to write the rhythm of the verse itself, one can utter syllables composed of the same letter, e.g. *ba*, *bam*, *pap*, and then have the lip write on the kymograph. You then get pictures like the followings:
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> Fig. 1.
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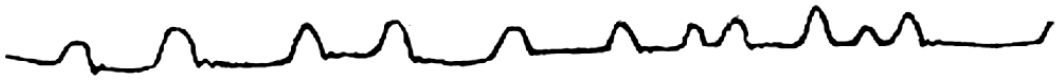
> 
>
> Fig. 2.
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> Fig. 3.
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> Fig. 1 shows an alcaic line of verse formed from the syllable *pap*. Movement was made by the lower lip, so that the curve at *a* was a valley, at *p* always a peak. [...] In Figure 2, the syllable sequence *bimbám bambámbam bámbabam bámbabam* has been written in the alcaic rhythm; the arsis peaks are also at the lowest ends of the descending parts of the second, fourth, sixth, and ninth dents. [...] In Fig. 3, I have shown an alcaic line of verse formed entirely of the syllable *ba* to show how the curve forms, when the syllables develop throughout not from consonants but vowels. (*The Physiological Bases of the New High German Prosody*, p. 32-33, my trans.)

He also proved by using the kimograph that the traditional saying: "the stress makes it long *[Der Accent macht lang]*," was utterly wrong and that an unaccentuated syllable could last twice as long as the previous one which was accentuated, as for example in *abfahrtsboot* (p. 58). Since the modern German metric rhythm was based on accents and not on durations, it was thus possible to alter the utterance speed of some syllables to accommodate it. Brücke retrieved, in this instance, a conclusion that had already been reached by Aristotle and Augustine, although in a

different metric systems and for very different reasons: rhythm is more important than meter (see vol. 1, p. 97 *sq.* and p. 334).

> On the arsis, i.e. when the expiratory pressure reaches its maximum, its climax, from which it sinks again, there may be any syllable which can be stressed by the expiratory pressure without distorting the pronunciation of those which are next to it. It is quite indifferent whether the syllable is long or short in itself, i.e. whether it requires much or little time for pronunciation in the ordinary language. In verse you can always spend [on each one] as much time as the rhythm demands. (*The Physiological Bases of the New High German Prosody*, p. 83, my trans.)

Brücke recognized that many forms of German poetry escaped his description (p. 49-50). But he nevertheless concluded that new high German poetry was based on the regular recurrence of stronger and weaker accents, metric ictuses and natural linguistic stresses, at least for its main prosodic forms. Physiology's contribution finally only amounted to propose to substitute the old metric with a new one.

> The German verse consists of a succession of syllables, in the utterance of which the increase and decrease in the exhalation pressure is regulated in a certain periodic way according to time. The beat of the verse *[Den Takt des Verses]* is carried out by muscles capable of altering the volume of the thoracic cavity; the separation of the syllables is produced by the organs of speech in the narrower sense, including the larynx. (*The Physiological Bases of the New High German Prosody*, p. 83, my trans.)

Except indirectly when dealing with the pronunciation, the psychological side was not developed by Brücke but, like Helmholtz, he unsurprisingly found that the pleasure induced by what he called "poetic rhythm" was similar to that induced by "watching the play of the waves or the dance." It was triggered by "the periodic return of certain movements," which in poetry meant "the symmetrical movements in raising and lowering the voice."

> As the eye, watching the play of the waves or the dance, is pleased by the periodic return of certain movements, the ear is pleased by the symmetrical movements in raising and lowering the voice. (*The Physiological Bases of the New High German Prosody*, p. 6, my trans.)

Next chapter

