Rhythm as Form of Physiological Process (Part 2)

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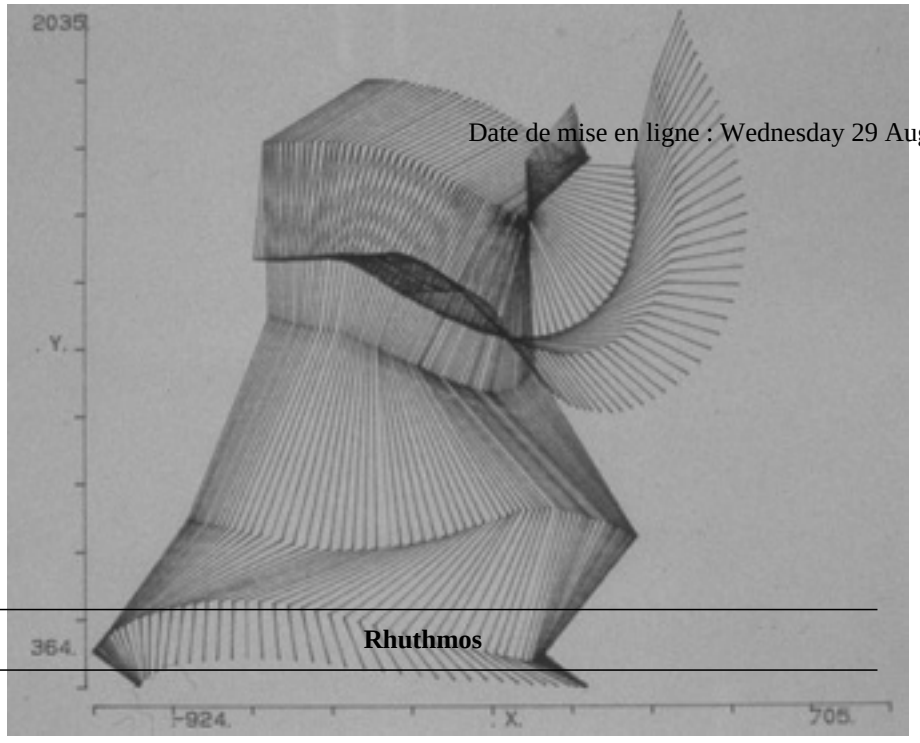

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Physiology of Musical Rhythm (Helmholtz - 1863)

The first physiologist, who took rhythm as subject of investigation *per se* instead of mere operating concept, was the German physicist, physiologist, and psychologist Hermann von Helmholtz (1821-1894). In 1863, Helmholtz 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 yet worth noticing that, as could be 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 provided 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*, 1863-1870, p. xiv-xv, trans. Alexander J. Ellis)

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 of the process 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 [composed] for several voices, was the so-called *discantus*, which emerged at the end of the eleventh century in France and Flanders. The oldest specimens of this kind of music which have been preserved are as follows. 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*, 1863-1870, p. 373-374, trans. Alexander J. Ellis)

What Helmholtz meant here by rhythm is not totally clear. Since each one of an ever growing number of singers was singing a different part around the *cantus firmus*, i.e. the pre-existing melody forming the basis of polyphonic composition, "time *[Takt]* had to be strictly observed." Yet "there was no integration of measure in the Gregorian *Cantus firmus*." Rhythm was thus probably synonymous with uneven 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. [But] there was no division of measure *[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*, 1863-1870, p. 374, trans. Alexander J. Ellis - my mod.)

Yet, although Helmholtz knew of the existence of unmeasured music 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 observable 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*, 1863-1870, p. 386, trans. Alexander J. Ellis, 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*, 1863-1870, p. 389, trans. Alexander J. Ellis)

Helmholtz turned then to the psychological effect of music on the mind. 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, he 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 too rapidly, and disturb rather than please. (*On the Sensations of Tone*, 1863-1870, p. 386, trans. Alexander J. Ellis)

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, the 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*, 1863-1870, p. 387, trans. Alexander J. Ellis)

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 the immediate audition only on condition that the alterations both in time and pitch 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*, 1863-1870, p. 387-388, trans. Alexander J. Ellis)

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 un-accentuated 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 unaccented 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*, 1863-1870, p. 388, trans. Alexander J. Ellis)

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*, 1863-1870, p. 3, trans. Alexander J. Ellis)

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, chap. 8 and 9), 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 Time Sense (Vierordt - 1868)

In the late 1860s, shifting from physiology to psychology, Karl von Vierordt conducted the first experimental research on time perception, the results of which he published in 1868 in *Der Zeitsinn: nach Versuchen - On Time Sense: an Experimental Study*.

As far as we are concerned, this book is of dual interest. On the one hand, it was the first time that psychology was not considered from the philosophical angle but from the scientific one. Vierordt made it clear, in his introduction, that if psychology was to become a scientific discipline, it was to be based on physics and physiology. He started by explaining the necessary relations between "the psychological viewpoint," "the physiological viewpoint," and "the physical viewpoint" (p. 3-11).

On the other hand, this essay has long been considered as one of the first to address the problem of rhythm from a psychological viewpoint. Already some years ago, Paul Fraisse claimed that Vierordt "start[ed] to record rhythmical movements *[des mouvements rythmés]* and to measure their regularity" (Fraisse, 1974, p. 7). And more recently, Jon E. Roeckelein praised him again for having "conduct[ed] the first experimental research on rhythm, determining the period of greatest regularity in the tapping of rhythms" (Roeckelein, 2008, p. 31).

Despite these two attracting assessments, Vierordt's contribution to rhythmology was actually very limited. The experiments he described involved indeed new measurement techniques. Vierordt used one or two metronomes as time giver, and a kymograph (or wave-writer - see vol. 2, p. 55-56), which helped to accurately measure the actions of a human guinea pig (himself) whom was asked to reproduce, after a certain space of time or immediately, by slight movements of the finger, various series of beats, from two to eight, following continuously or interrupted by pauses, repeated sometimes up to ten times, and perceived either by hear or by touch. By repeating these various experiments sometimes up to more than thousand times, the aim was to exactly assess the difference between *objective* time and *perceived* time. Vierordt provided a copious series of numerical result tables. Here below, three passages where Vierordt described his experiments.

The assistant indicated a time of arbitrary duration by striking the plate twice, and I had the task without seeing the movements of the lever apparatus to reproduce, from the two notes i.e. by focusing on the time interval between them, the time thus heard as accurately as possible by a corresponding movement of the lever apparatus. There was to be no interval between the main laps of time indicated by the assistant and the one to be imitated by me; thus the second chink of the glass plate indicated the beginning of the reference time, so that I merely had to press the plate [once again] by means of a very small finger movement. The results are summarized, in their average values, in the following table consisting of 1104 individual experiments. (*On Time Sense*, 1868, p. 35, my trans.)

If one seeks to reproduce the periodic beats one has heard *[gehörte periodischen Schläge]* immediately after the last beat *[Schlag]* on the kymograph, one is convinced to have given equal size to the intervals, although the measurement of the individual intervals does not deliver a perfect equality. In our experiments, however, when measuring the times reproduced on the kymograph, the 7 intervals of each individual experiment were not measured for themselves, but only the total duration of the 7 intervals. (*On Time Sense*, 1868, p. 45, my trans.)

Accordingly, I set myself the task of recording three successive small strokes of the hand *[Taktbewegungen der Hand]* by means of the writing lever apparatus on the kymograph so that the two measures *[die zwei Takte]* should have exactly the same duration. (*On Time Sense*, 1868, p. 50-51, my trans.)

One of Vierordt's conclusions, among many others, was that human perception of time was varying according to the duration of the intervals between two beats, i.e. to the tempo: short durations tended to be overestimated, while long durations tended conversely to be underestimated. Another one was that, in the case of one or several series of beats, perceived time was varying according to its total duration, frequency, and number of repetition, sometimes appearing shorter, sometimes longer than it objectively was.

Yet most noticeably unless I am mistaken the term rhythm was never used in the book. Vierordt never mentioned it and most probably was not interested in it. This does not mean, though, that Vierordt's contribution on time sense is of no concern to rhythmology. But, since there is so much confusion on this subject, we better be cautious and precise. As we saw in a previous section, in his physiological writings Vierordt very rarely used rhythm as synonymous with regular series of beats. Most of the time, he quite traditionally assimilated rhythm with alternation of contrary movements which were not necessarily of the same duration. Since he was now dealing with the perception of time measured by metronomes, he restricted his concern to strictly periodic measures and beats, in German *Takt*. This probably explains why he refrained from using the term rhythm in this particular book, whereas he used it many times in *Outline of Man's Physiology*, published a few years later.

From this we may conclude that, contrarily to Fraisse's and Roeckelein's contentions, Vierordt did not exactly "start to record rhythmical movements and to measure their regularity." He did not either "conduct the first experimental research on rhythm, determining the period of greatest regularity in the tapping of rhythms." First of all, he was not concerned with "rhythmical movements" or "tapping of rhythms" but with the perception of duration measured by a succession of metronomic beats. Secondly, I do not think that we should carelessly project later categories on our subject and equate, as it has been made only a few decades later, rhythm with regular beat. What we may say however is that, although Vierordt did not formally introduce rhythm into psychology, something which actually had already be done by Helmholtz in 1863, he certainly participated, although quite indirectly, in the shift that was changing rhythm as *variable succession of alternative movements* into *complex succession of beats* (see vol. 2, chap. 2).

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