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Rhythm as Form of Physiological Process (part 3)

- Recherches

- Le rythme dans les sciences et les arts contemporains

- Psychologie - Nouvel article

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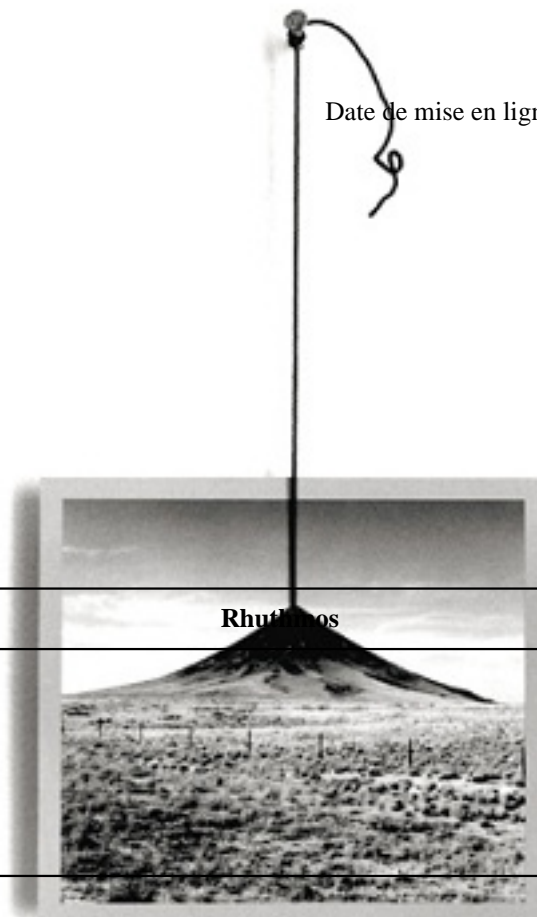


Table of contents

- [Physiology of Cardiac and Respiratory Rhythms \(Wundt - 1864\)](#)
- [Physiopsychology of Auditory Rhythm \(Wundt - 1873\)](#)

[Previous chapter](#)

Physiology of Cardiac and Respiratory Rhythms (Wundt - 1864)

In 1855, Wilhelm Wundt (1832-1920) majored at the University of Heidelberg in medicine. But doctoring was not Wundt's vocation and he turned instead to physiology, which he studied for a semester under Johannes Müller the "father of experimental physiology" at Berlin. In 1856, at the age of 24, Wundt took his doctorate in medicine at Heidelberg, but habilitated as a Dozent in physiology. Two years later, he became an assistant to Hermann von Helmholtz, position in which he remained until 1865, with responsibility for teaching the laboratory course in physiology. His first research resulted in the *Lehrbuch der Physiologie des Menschen - Textbook of Human Physiology* published in 1864-1865 [1].

In this *Textbook*, Wundt often used the term rhythm, as it was still customary in his time in medicine and physiology, to refer to the *alternation* of the diastole and systole whose successive durations were *in a certain ratio* (p. 295, 297, 318, 321, 332, 335).

Donders imitated the rhythm of the heart sounds perceived by the stethoscope by movements of the hand and let these movements register on a rotating cylinder. (*Textbook of Human Physiology*, 1864-1865, p. 295, my trans.)

He used it also, on the same semantic basis, to refer to the *alternation* of respiratory movements.

1. Rhythm of respiratory movements. The movements of the breath consist of rhythmic changes in the space of the chest cavity, which are caused by the successive contractions and relaxations of certain muscles. (*Textbook of Human Physiology*, 1864-1865, p. 355, also p. 392, 393, 394, my trans.)

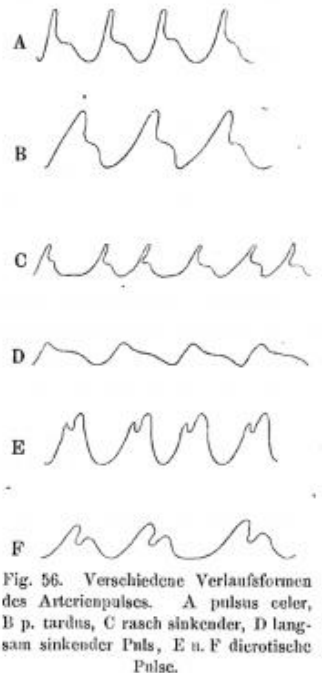
As its cardiac counterpart, the rhythm of respiration explicitly implied a *ratio* between inspiration and expiration which yet could voluntarily vary.

The rhythm of the breath is a very regular one. The inspiration is shorter than the expiration, according to Vierordt, in the ratio of 10: 14-24. Inspiration transforms directly into expiration. But on the other hand, before any new inspiration, there is a pause that is $\frac{1}{5}$ - $\frac{1}{3}$ of the total duration of one respiration. (*Textbook of Human Physiology*, 1864-1865, p. 356, also p. 374, my trans.)

For this very reason, as Vierordt before him, the young Wundt still clearly distinguished rhythm from *beat* or *pulsation*

With a very significant increase in pressure, however, the number of cardiac pulsations [*Herzpulse*] may decrease again, while at the same time the regular rhythm [*regelmässige Rhythmus*] of the latter is usually disturbed (Heidenhain). (*Textbook of Human Physiology*, 1864-1865, p. 318, my trans.)

Yet, unsurprisingly, the "pulse" was increasingly described as "pulse wave - *Pulswelle*" or "pulse curve - *Pulscurve*" and represented through figures taken from the latest studies with Vierordt's and Marey's sphygmograph (as in fig. 56, p. 311). It was also measured by its *frequency*, i.e. the number of recurring beats by time unit. For example, in the chapter dedicated to "The Blood and the Blood Movement," Wundt often spoke of "pulse frequency - *Pulsfrequenz*" (p. 322, 324, 325, 327, 328, 330, 331, 360) and logically of "pulse acceleration - *Pulsbeschleunigung*" oder "*Pulvermehrung*" (p. 324, 326, 327, 328, 329).



Noticeably, Wundt did not use the term rhythm in these instances. He was still faithful to the ordinary meaning of the term in medicine and physiology.

Physiopsychology of Auditory Rhythm (Wundt - 1873)

In the mid-1860s, Wundt made a new move, though, which was to lead him from physiology to plain psychology and simultaneously to endorse a different conception of rhythm. From 1864, he began to lecture on what he called "physiological psychology." This new research took him another ten years and he finally published in 1873-1874 his first well-known book *Grundzüge der physiologischen Psychologie - Principles of Physiological Psychology*, which was expanded and republished six times (last. ed. 1908-1911). This was the first textbook ever written pertaining to

the field of experimental psychology.

In the *Principles*, Wundt's interest in rhythm was actually only incidental to the more focal problems of "span of consciousness" and "synthetic activity of consciousness." He dealt with the question only in three limited instances in the third part of the book.

After having described the "Physiological Characteristics of the Nervous System" (Part 1), then the "Sensations" (Part 2), Wundt analyzed the "Ideas" evoked in the consciousness by the various sensations generated by the nervous system (Part 3) [2]. "Taste and Movement Ideas" were first dealt with (Chap. 12), then "Auditory Ideas" (Chap. 13), "Ocular Ideas" (Chap. 14), "Imagination Ideas" (Chap. 14), "Complex Ideas, General Ideas and Intuition Forms" (Chap. 16) and, finally, the "Aesthetic Feelings" (Chap. 17).

Rhythm was thus first discussed in a short section of the chapter dedicated to "auditory ideas," along with "constant sound," "harmony," "minor and major chords" (Chap. 13). The second instance was in the chapter where Wundt addressed the Kantian problem of the "intuition of time and space" (Chap. 16). And the last one was in the last chapter of the third part dedicated to the "aesthetic feelings" (Chap. 17). In my comments, I will follow the same order.

To begin with, it is worth noting that whereas, in his previous physiological research, Wundt used almost exclusively the traditional medical concept of rhythm (*alternation* associated with *ratio*), he immediately introduced, in his psychophysiological studies, a new concept borrowed from music, at least as it was commonly defined in his time, and this not only to address its aesthetic aspect, as it was still the case with Helmholtz, but as a basic tool to describe one particular kind of "auditory idea."

Wundt started by contrasting rhythm with harmony and melody. All of them were related to the translation of our successive sensations of hearing into a succession of sound ideas; but whereas the latter implied "qualitative changes," the former resulted from "intensive changes." From the outset, the rhythm was equated with a regular succession of rises and falls in sound intensity.

For the development and completion of the notion of time [*Zeitauffassung*], however, the *intensive* change of sound is of greater importance. One and the same sound can be set stronger or weaker. If such rises and falls [*Hebungen und Senkungen*] follow one another with a certain regularity, the sounds are thereby *rhythmically* articulated [*rhythmisch gegliedert*]. (*Principles of Physiological Psychology*, 1873-1874, p. 513, my trans.)

But rhythm was not dependent only on the auditory system. It was also related with innate bodily capabilities and, therefore, also defined as "regular rhythmic alternation of movements." Due to "the arrangement of the locomotor organs," Wundt noticed, both kinds of rhythm entrained each other.

However, the change in sound intensity has its nearest model in the nervous feelings that accompany our own movements. For the arrangement of the moving limbs, especially the locomotor organs, explains the disposition toward a regular rhythmic alternation of movements [*einem regelmäßigen rhythmischen Wechsel*]. Thus, during dancing, marching, and beating, a corresponding rhythmic sequence of our movements joins, with an almost irresistible force, with the alternation of sound perceptions. (*Principles of Physiological Psychology*, 1873-1874, p. 513, my trans.)

Rhythm as Form of Physiological Process (part 3)

From an evolutionary viewpoint, bodily rhythm had most probably anticipated auditory rhythm but the latter had eventually developed upon and refined the former. While being related to each other, bodily and auditory rhythms resulted from different degrees of evolution and were, therefore, endowed with various levels of sophistication.

Inspired by our movement, in which we find the earliest rhythmic [*das Rhythmische am frühesten finden*], we call rhythm in general a movement that progresses according to a precisely determined measure [*eine nach genau bestimmten Maass fortschreitende Bewegung*]. But the subtlety with which our ear understands the steps of the rhythmic movement [*die Schritte der rhythmischen Bewegung*] makes it surpass our original sensations of movement. On the one hand, it differentiates temporal parts as fractions of bar, which are no longer discernible in one's own movement. On the other hand, it is able to immerse itself in rhythms whose slow progress can no longer be reproduced in the movement of our body. (*Principles of Physiological Psychology*, 1873-1874, p. 517-518, my trans., same idea p. 520)

In the fifth edition of the *Principles* (1902), which was partly translated into English (1904 - 2nd ed. 1910), Wundt more precisely, if cautiously, explained this interaction between auditory and movement rhythms by the close localizations of the concerned nervous centers in the brain.

The acusticus is precisely the sensory nerve that gives certain objective sense impressions a specific relation to movement; our movements adapt themselves involuntarily, in a corresponding rhythm, to rhythmical impressions of sound. (*Principles of Physiological Psychology*, 1902, ed. 1910, p. 276, trans. Edward B. Titchener)

The connexions with certain sensorimotor and regulatory centres, in particular, centres like the pregemina, cerebellum, etc., can, in the present state of our knowledge, be referred only quite generally to the interactions between auditory impressions and rhythmical movements. (*Principles of Physiological Psychology*, 1902, ed. 1910, p. 299, trans. Edward B. Titchener)

Having defined rhythm as *alternation* of acoustic rises and falls or bodily movements, Wundt explored the range within which the rhythm could develop. Since rises could be performed in three progressive ways (low, medium, high), he classified the "rhythmic structures" from the simplest one the bar containing two alternate sounds to the most complex ones one bar containing three or four alternate sounds, each possibly endowed with three different degrees of intensity.

The simplest rhythmic structure [*Das einfachste rhythmische Gebilde*], which consists of a certain number of well-defined rises and falls of the sound, is called the *bar* [*den Takt*]. The simplest possible form of time signature [*Taktform*] is the 2/8 time signature, in which rise and fall [*Hebung und Senkung*] regularly alternate without further gradation. On the other hand, the 3/4 and 4/4 time signatures [*Taktformen*], in which all three degrees [in the intensity] of rising are represented, constitute the upper limit of the more common ones [...]. The 2/4-time signature, in which two degrees of rising can be distinguished, is in a middle position. (*Principles of Physiological Psychology*, 1873-1874, p. 514, my trans.)

Rhythm as Form of Physiological Process (part 3)

According to Wundt, all other "rhythmic structures" could be reduced to the four previous ones.

Several other kinds of time signatures [*Taktformen*], which are still admitted, can all be reduced to the four enumerated here, so the 2/1 and 2/16 to the 2/8, the 3/2 to the 3/4, the 2/2 and 4/8 to the 2/4; others are extensions of the same, in which the number of falls, which follow a rise, is increased by one or a few. In this way the 3/8 time signature arises from the 2/8, the 9/8 from the 3/4, the 6/4 and 12/8 from the 4/4, the 5/8 from the 2/4 time signature. Finally, two simpler time signatures, with regular alternation, can form a more complex one: thus, the 5/4 time signature is only a combination of the 3/4 and 2/4 time signatures. (*Principles of Physiological Psychology*, 1873-1874, p. 514-515, my trans.)

Like the musicians, Wundt distinguished two- and three-part time signatures (nowadays duple and triple meters), as well as mixed ones "which are composed of two- and three-part elements at the same time" (p. 515).

He then addressed the question of accentuation. As it was already customary in music, he used "rise" or "arsis" as synonymous with "strong beat," i.e. contrarily to the original Greek meaning of unaccentuated note. But he noticed that a bar could "begin with the arsis as well as with the thesis," at least in duple meters.

It is only a matter of convention that every bar should begin with the strong beat [*mit dem schweren Takttheil*], and in the more complex time signatures [*Taktformen*] with the strongest rise [*mit der stärksten Hebung*] [...]. Actually, every bar [*Takt*] can begin with the arsis as well as with the thesis, and for the formation of the two-part bars the two forms [...] must indeed be regarded as equally possible. This is different with the tripartite measures. Here the practice of both modern and ancient rhythmic [*Rhythmik*] shows that the strong beat [*der schwere Taktteil*] is always sandwiched between two weaker ones [*zwischen zwei leichteren*]. (*Principles of Physiological Psychology*, 1873-1874, p. 515, my trans.)

Following the classification of time signatures, Wundt described the building of a whole piece of music by way of connecting the smallest units into increasingly larger units. The first of these aggregated units he called "rhythmic series" or "phrase," which corresponded to a "line of verse" in poetry. Second order units were called "rhythmic periods."

A certain number of bars [*Takten*] join in a *rhythmic series* [rhythmischen Reihe] [Footnote : It is usually referred to as a phrase [*Absatz*] in musical metric, and as a line of verse [*Verszeile*] in poetry.]; the *rhythmic period* [rhythmische Periode] builds up from a number of series. These more complex constituents of the rhythm are also enclosed between a lower and an upper limit. (*Principles of Physiological Psychology*, 1873-1874, p. 516, my trans.)

For physiological reasons, the "rhythmic series" could range from two to six bars, not more, but the "rhythmic periods" could be composed only of two series, not more, except in poetry.

The smallest rhythmic series consists of *two* bars, the largest of which, as the musical and poetic metrics equally show, is formed by *six* bars. In music, the medium between these extremes, the even-numbered series of *four* bars, is the ordinary form. Rhythmic series, which go beyond six bars (the hexapody), are extremely rare. For the *period* [Periode] (or stanza [*Strophe*]), too, *two* is the smallest number of series of which it is composed, and it is at the same time the most usual one: the first series forms the anterior phrase [*Vordersatz*], the second the posterior phrase [*Nachsatz*]. Relatively rare, and almost only in poetic rhythm, which in this respect provides a greater range against monotony, three, four and even five series can be connected with each other. (*Principles of Physiological Psychology*, 1873-1874, p. 516-517, my trans.)

Rhythm as Form of Physiological Process (part 3)

Beyond these limits, Wundt claimed, the perception/ideation of rhythm begins to blur and the connectedness of a piece has to be sustained by the melody.

In music, the whole divided into bars, series and periods [*Takte, Reihen und Perioden*] is often composed into larger sections or phrases [*Abschnitte oder Sätze*]. But these sections lack rhythmic clarity [*die rhythmische Übersichtlichkeit*]. They find their connection not in rhythmic motives, but in melody. (*Principles of Physiological Psychology*, 1873-1874, p. 517, my trans.)

[Next chapter](#)

[1] Kim, Alan, [Wilhelm Maximilian Wundt](#), *The Stanford Encyclopedia of Philosophy* (Fall 2016 Edition), Edward N. Zalta (ed.)

[2] Wundt defined "an idea - *eine Vorstellung*" as, "according the common meaning of the word, the image of an object produced in our consciousness [*in unsern Bewusstsein erzeugte Bild eines Gegenstandes*]." (p. 464, my trans.)