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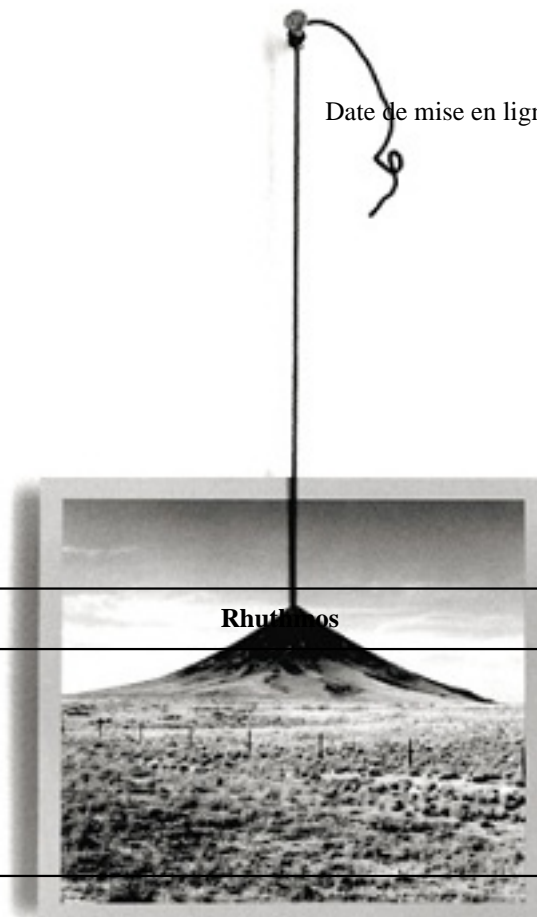
Rhythm as Form of Physiological Process (part 1)

- Recherches

- Le rythme dans les sciences et les arts contemporains

- Psychologie - Nouvel article

Date de mise en ligne : Thursday 28 June 2018



When, in 1974, Paul Fraisse (1911-1996) published *Psychologie du rythme - The Psychology of Rhythm*, which was meant to synthesize the main results of the last hundred years of research in psychology concerning rhythm, he started by recalling Benveniste's analysis of the notion of rhythm in Ancient Greece (p. 5-6). However, between the two opposite meanings the materialist "particular way of flowing" and the Platonic "order in movement" (see vol. 1, chap. 1 and 2) he explicitly favored the latter and extended it to the more modern notion of periodicity (see vol. 2, chap. 1 and 2).

A psychology of rhythm must start from the rhythm of human activities, these temporally ordered movements for which Plato specialized the concept. Since then, we have generalized the use to all periodic phenomena. (P. Fraisse, *Psychologie du rythme*, 1974, p. 9, my trans.)

By endorsing the Platonic paradigm, Fraisse was not innovating: on the contrary, he was only sanctioning the transformation of the rhythm concept at the hands of psychologists during the second half of the 19th century. In this chapter, I will try to identify the main steps of this Platonic spread in psychology.

First Step into the Physiology of Rhythm (Vierordt - 1855-1871)

After 1860 psychology began to emancipate itself from philosophy and to bond with natural science, especially physiology. Yet, surprisingly, there was no direct translation of the rhythm concept from the latter to the former. This can be exemplified by looking at the contributions of the physiologist and psychologist Karl von Vierordt (1819-1884).

Vierordt was educated as a medical doctor and began studying breath in the 1840s. Then his interest shifted to blood circulation. In 1854, he created a device he called a "Sphygmograph," which was rapidly used in different countries to record on paper the variation of blood pressure. Marey improved it in France a few years later and became instrumental in the semantic shift of the rhythm concept from *alternation* and *ratio* to *beat* and *wave* in medicine and physiology (see vol. 2, chap. 2). Thanks to his new device, he was able to run new experiments and publish in 1855 a full treatise on arterial pulse: *Die Lehre vom Arterienpuls in gesunden und kranken Zuständen - The Theory of the Arterial Pulse in Healthy and Sick States*. In 1861, he wrote a very successful textbook entitled *Grundriss der Physiologie des Menschen - Outline of Man's Physiology* which was republished four times (last ed. 1877). In the late 1860s, switching from physiology to psychology, Vierordt conducted the first experimental research on time perception, whose results he published in 1868 in *Der Zeitsinn: nach Versuchen - On Time Sense: an Experimental Study*. Yet, as we will see, Vierordt's remained most often within the frame of the old medical paradigm and did not achieve a full translation of the rhythm concept from physiology to psychology.

In the first chapter of *The Theory of the Arterial Pulse* (1855), Vierordt recapitulated the main previous medical contributions on the subject. He recalled the work of "Josef Struth" in the 16th century (1540 - see vol. 2, p. 18 sq. - he mentioned the 1555 ed.). Since he was directly quoting Struthius, rhythm was here clearly and very traditionally synonymous with *ratio* between the respective durations of expansion and contraction of the artery (see vol. 2, p. 18-25).

If we now address one of the next problems of pulse semiotics, we must admit at once that the important relation of the durations of the expansion and contraction of the artery cannot be perceived [...] by the feeling. This is what our Struth admits when he says : "*Rhythmi non noscentur, nisi integra tempora distentionis et contractionis noscantur. - Quod vero ignota sint integra tempora motus utriusque; inde constat, quoniam et motus distensionis et contractionis integer, nobis cognitus esse non potest.*" (*The Theory of the Arterial Pulse*, 1855, p. 2, my trans.)

Rhythm as Form of Physiological Process (part 1)

Vierordt alluded next to François-Nicolas Marquet's *Nouvelle méthode pour connaître le pouls* (1744 - see vol. 2, p. 38 sq. - he mentioned the 1769 ed.) which he acknowledged as a legitimate attempt at "expressing the pulse in notes of music" while terming it a "naive doctrine." Rhythm seemed then to refer to the new musical meaning based on the regular succession of bars and beats which developed during the 18th century.

Later medicine is not entirely poor [on that matter], though it has failed to set up clear symbols for the rhythm of the pulse [*Rhythmik des Pulses*] allegedly observed through the sense of touch, in order to sharpen the description of the pulse. So a physician in Nancy, Marquet [...] tried to express the pulse in notes of music. [...] Numerous engraved music examples served as an explanation of this naive doctrine. (*The Theory of the Arterial Pulse*, 1855, p. 18, my trans.)

But a few pages below, Vierordt used again the term "*Rhythmik*," clearly referring, this time, to the succession of beats and waves as it was recorded with the Sphygmograph he had just invented in 1854 (see vol. 2., p. 56). As a matter of fact, Vierordt provided a large number of figures representing records of pulse waves (similar to those taken in Marey's, Kries' and Ewart's books which I provided in vol. 2, chap. 2).

It sometimes happens that the artery evades the platelet; here, the best way is to compress the artery slightly below the observation point of the pulse; the rhythm of the latter [*die Rhythmik des letzteren*] is not disturbed by this. (*The Theory of the Arterial Pulse*, 1855, p. 33-34, my trans.)

Noticeably, these three acceptations of the term rhythm were almost exceptions in his book, either because they belonged to the past or contrarily, for the last one, to a much too modern conception. Most of the time, Vierordt used rhythm as *regular alternation* or as mere *succession of alternate movements, regular or not*. He considered, for instance, the binary movement of respiration as much rhythmic as the heart motion.

The reason why the systole and diastole of the ventricles last approximately the same time in humans, however, is still an unsolved problem of the theory of heart movements [...] The answer to this last question, on which my attempt stumbled, remains unsettled, and I can, at the most, draw attention to analogous processes of rhythmic movements in muscles during animal action. In frequent respiration, the duration of inspiration and expiration is approximately the same; the muscles of inspiration rest about as long as they are in action; the same applies to the exhalers. When acting, the muscles show similar rhythmic alternation between work and rest. (*The Theory of the Arterial Pulse*, 1855, p. 70, my trans., same use p. 123)

The rhythm of respiration is thus here an arbitrary one; in order to make the effects of respiration more pronounced, it is also possible to purposely take a deep breath. I have followed this method in my experiments on this question. One uses a suitable lever device for recording the respiratory movements on the kymograph. (*The Theory of the Arterial Pulse*, 1855, p. 190, my trans.)

If we look now at his very famous *Grundriss der Physiologie des Menschen - Outline of Man's Physiology*, published in 1871, it is worth noticing, to begin with, that Vierordt never used the term rhythm for the periodic development of

Rhythm as Form of Physiological Process (part 1)

the embryo. I could not find a single occurrence in the whole section dedicated to embryology (p. 604-658). This is one more piece of evidence showing that there was no "rhythm episteme" in the 19th century (for this dubitable thesis see Wellmann, 2010) and, moreover, that rhythm was not a concept used by the new developmental physiology of the time, at least until the 1900s (for a discussion of this contention, see vol. 2, chap. 5).

In his *Physiology*, Vierordt used instead the term rhythm mainly in three ways. The first referred to a *strictly regular succession of phenomena*, as the beating of a clock actually, in this particular instance, of the regular meeting of two slightly desynchronized clocks. This use appeared but only once in the section dedicated to hearing.

A sound that hits both organs of hearing, albeit unequally, is *simply heard*. But the fusion of the sensations of both organs has its limits; one gets, for example, different impressions as one hears two clocks of slightly different beating speed with one or both ears (E. H. Weber). In the first case, one distinguishes the periods where the beats of both clocks meet, and considers them as a repetitive rhythm. If, on the other hand, a clock is held in front of each ear, one is able to decide which one beats faster but not to [recognize] any of the rhythms [*aber jener Rhythmus fehlt*]. (*Outline of Man's Physiology*, 1871, p. 334, my trans.)

The second use equated rhythm with *a series of cycles* or *a periodic recurring*. This use was naturally prevalent in the section dedicated to "Periodische Körperzustände - Periodic Body States" (p. 591-604). It also appeared in the section concerning the contractions of childbirth (p. 571) or to describe the flow of the blood in arteries (p. 141).

A closer examination of the course of the normal functions may lead to observe the constancy of certain cycles, including several days cycles. The very phenomena of the three-day, four-day, and above all of the very rare, seven-day pathological rhythm, and the strange multipla of the latter, to which menstrual cycles belong, all point to this. [But] this subject, as well as the previous attempts to demonstrate multi-day rhythms in normal life in various functions cannot be discussed here. (*Outline of Man's Physiology*, 1871, p. 600, my trans.)

Most of the time, though, Vierordt used rhythm, in a rather traditional way in medicine, as synonymous with *alternation of two contrary movements of various durations*, whether by some body muscles under nervous stimulus (p. 74, 83, 95), the heart (p. 123, 124, 125, 127, 129, 145, 209), the arteries (p. 138), the respiration (p. 145, 202, 497, 579), the brains skins (p. 491), or the contractions of childbirth (p. 521). A full section of the chapter on "Blood Circulation" (chap. VII) was dedicated to the "Rhythmic of the Systole and the Diastole" (§ 128, p. 119) and another one in the chapter on "Respiration and Perspiration" (chap. X) to the "Rhythmic of Respiratory Movements" (§ 212, p. 202-203). One particularly illustrative example will suffice here.

When respiratory gas exchange is maintained to a sufficient degree by periodic injection of air into the trachea, a curarized animal, whose *nervi vagi* have been cut out, shows an alternating rise and fall [*ein abwechselndes Steigen und Sinken*] in the arterial blood pressure, as a result of a periodic increase and decrease in the activity of the vascular muscles [*in Folge einer periodischen Zu- und Abnahme der Thätigkeit der Gefäßmuskeln*]. The stimulus to this rhythmic movement probably originates from alternating states of the medulla oblongata, as respiratory center. (*Outline of Man's Physiology*, 1871, p. 209, my trans.)

Rhythm as Form of Physiological Process (part 1)

To put it in a nutshell, Vierordt's own physiological studies delivered nothing but well-known notions of rhythm, all derived from medicine and pertaining to the Platonic Paradigm.

Let us turn now to his groundbreaking contribution to psychology. This was the first time that psychology was not considered from the philosophical angle but from a scientific one. In *Der Zeitsinn: nach Versuchen - On Time Sense: an Experimental Study* published in 1868, 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 physical viewpoint," "the physiological viewpoint," and "the psychological viewpoint" (p. 3-11).

The experiments he then described involved new measurement techniques. Vierordt used one or two metronomes as time giver, and a Kimograph (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. the tempo: short durations tended to be overestimated, while long durations tended conversely to be underestimated. Another one was, in the case of one or several series of beats, that 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. There was thus no direct translation of the concept from medicine and physiology to psychology. 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 just saw, 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 the term rhythm was not used in this particular book, whereas it was used many times in *Outline of Man's Physiology*, published a few years later.

From this we may conclude that, contrarily to some specialists' contention, Vierordt did not exactly "start to record rhythmical movements [*des mouvements rythmés*] and to measure their regularity" [1]. He did not either "conduct the first experimental research on rhythm, determining the period of greatest regularity in the tapping of rhythms" [2]. First of all, he was not concerned with "rhythmical movements" or the "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, he certainly prepared the shift that was soon to occur from rhythm as *variable succession of alternative movements* to *complex succession of beats* at the hands of the new physiopsychologists.

[Next chapter](#)

[1] P. Fraisse, *Psychologie du rythme*, Paris, 1974, p. 7.

[2] Jon E. Roedelstein, "History of Conceptions and Accounts of Time and Early Time Perception Research" in S. Grondin, *Psychology of Time*, 2008, p. 31-32.