Rhythm as Form of Psychological Process (part 1)

- Recherches
- Le rythme dans les sciences et les arts contemporains
- Psychologie - Nouvel article
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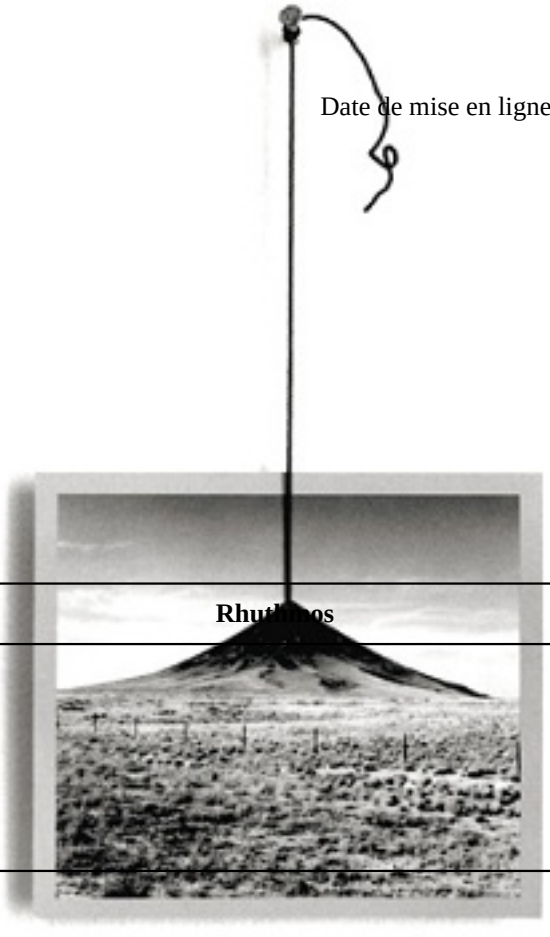

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From Physiology to Psychology (Vierordt - 1855-1871)

After 1860 psychology began to emancipate itself from philosophy and to bond with natural science, especially physiology. But 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 beat to 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.)

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 strong and weak beats*, *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 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. W e b e r). 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.)

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 Kimographion (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 noticeably unless I am mistaken the term rhythm was never used in the book. There was no direct translation of the concept from medicine and physiology to psychology. This does not mean, though, that Vierordt's contribution 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 specialist's contention, Vierordt did not exactly "conduct the first experimental research on rhythm, determining the period of greatest regularity in the tapping of rhythms" [1]. First of all, he was not concerned with the "tapping of rhythms" but with the perception of duration measured by a succession of 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 a few years later from rhythm as *variable succession of alternative movements* to *regular succession of beats* at the hands of the new physiopsychologists.

Physiopsychology 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 id *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 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)

Poetry was, Helmholtz claimed, only about producing "images" which could stimulate "imagination and memory." Sound and rhythm were 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.

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