FILOZOFIA I NAUKA
Studia filozoficzne i interdyscyplinarne
Tom 13, 2025

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THE PHENOMENOSCOPIC ANALYSIS OF THE INTRAVISIBLE

https://doi.org/10.37240/FiN.2025.13.1.3

ABSTRACT

"Phenomenoscopic analysis" differs from the phenomenological analysis of the vision of the essence of phenomena highlighted, with an appropriate intentional act, as pure object; phenomenoscopic analysis instead regards this vision as organically linked to the phenomenal appearing of the physical meaning inherent in the experimental datum identified and expressed mathematically; therefore, said vision is not pure but rather *integrated* with "visivation," i.e. the *highlighting* of the factor, also phenomenal, which constitutes the necessary condition for its actual appearing. This factor is not immediately visible because it transpires from *within* the datum perceived on the surface. It is only "intravisible" and therefore must be shown by means of a particular thought experiment: one suitably reintegrated with its inalienable visual-perceptual component and thus qualified—more so than the kind generally employed in philosophical and scientific demonstrations—to make visible the crucial factor otherwise unseen or merely glimpsed. For this reason, said factor is not taken into account in the *intuitive* and not strictly *perceptual* visualisation of the *physical meaning*, which thus remains devoid of that phenomenal visibility which makes the indispensable empirical verification possible (according to Wittgenstein's words: "The inexpressible certainly exists. It shows itself"). As a proof of the validity of this different methodological and epistemological approach, here we present a phenomenoscopic analysis of the mental experiments—singularly alike in this regard—developed, on the one hand, by zeno of elea in the kinematic paradox of Achilles and, on the other hand, by Einstein in his Special Theory of Relativity *demonstrations*. The phenomenoscopic analysis of the intravisible, therefore, highlights the fact that the discovery of the essence of phenomenal reality requires not the separation but, on the contrary, the mutual integration of the scientific point of view and the philosophical one, both necessary, while maintaining their respective functions distinct. Indeed, it is first and foremost the mathematical recognition of the real datum that enables logical deduction to pose the ensuing theoretical problem in the correct terms; the demonstration that it is in line with the real data and with the objective solution to the actual problems is up to their "visivation," which allows one

to glimpse their phenomenal essence and the metaphysical meaning inherent in the physical one. Ultimately, it follows that the objectivity of scientific and philosophical knowledge is not founded on unilateral "phenomenological evidence", which is inevitably subjective (as Jan Łukasiewicz acutely observed and highlighted in contrast to Edmund Husserl), but rather on a homogeneous, integrated synergy between science and philosophy which preserves their distinct but correlated functions.

Keywords: Phenomenoscopic analysis, appearing, demonstration, mental experiment intravisible, observation, physico-phenomenal meaning, visivation.

THE INTRAVISIBLE AND THE THOUGHT EXPERIMENT

Johann Wolfgang von Goethe's pregnant quotation "Words are not enough to make us understand the true meaning" is still relevant today, as is Charles Sanders Peirce's "Man is a sign," which remains the motto of influential modern and contemporary schools of thought (neo-positivism, falsificationism, analytic philosophy, semiotics, etc.)

A belief that words, or signs in general, are not enough, was what distinguished—in various and not always explicit ways—the phenomenological movement, which developed in parallel under the impulse of Franz Brentano's and Edmund Husserl's "rediscovery" of intentionality as a key factor for a more rigorous knowledge of reality than the purely scientific kind, because the former is devoid of the naturalistic presupposition which conditions the latter. However, at the same time, an actual science of perception started to develop (in particular with the *Gestalttheorie*), which, with its innovative experimental discoveries, replaced Husserl's vision of the pure object with the vision of the perceived object, perceived in a form (*Gestalt*) generated by autonomous factors, which are different and independent of those related to thought (*Logos*). Thus, in the context of "classica+" phenomenology a distinctly perceptological trend emerged, particularly with Maurice Merleau-Ponty's phenomenology of perception, in which the primacy of perception is resolutely pursued. However, it too kept its distance from naturalistic science (including science of perception), while not disregarding its innovative experimental contributions.

Conversely, these were not taken into account by the opposite version, in particular Martin Heidegger's and Hans Georg Gadamer's phenomenological existentialism, centred again on the *Logos*, although neither scientific nor metaphysical in the traditional sense, but rather philosophico-poetical, tending towards an evocative silence. Despite these heterodox developments, or rather because of them, Husserl's phenomenological "dream" seems to have ended, as the "later" Husserl admitted with regret. On the other hand, the analytical and epistemological orientations also seem to be

subject to a similar impasse, despite the "later" Wittgenstein's overtures regarding perceptological problems and perspectives.

Within this complicated philosophico-scientific context, the concept of the "Intravisible" (or "Glimpsable")—with its implications and perspectives, both theoretical and experimental—is presented as a suitable factor to address and clarify some significant critical points arising within a still quite heterogeneous philosophico-scientific scene. Indeed, it can prove suitable to integrate effectively a demonstration tool—the thought experiment—which is particularly useful in acquiring more exhaustive knowledge of the physical and metaphysical principles that constitute the foundations upon which, since the dawn of Western thought (from Zeno to Albert Einstein), philosophy and science are based, sometimes overlapping. However, even its most lucid and methodical theorization and application, namely Ernst Mach's, did not fully succeed in achieving the right balance regarding the scopes and roles relative to each of the two essential components of the thought experiment (*Gedankenexperiment*), indicated in its very name: that of thought, which pertains to the sphere of the *Logos*, and that of experiment, which pertains mostly to the sphere of *perceptual vision* (not just intentional, as in Franz Brentano's view).

The clearest awareness and the most explicit prescription of the need for a well-measured balance between these two components find expression not so much in Zeno—too influenced by the then accepted principles of Parmenidean metaphysics—as in Einstein. His methodical use of the thought experiment (which Max Jammer refers to as his favourite demonstration technique, though in truth it was the "only" alternative) makes him in this regard an essential point of reference—also because it (i.e. the mental experiment) is not less instructive but actually more so, precisely because Einstein was not always able to achieve a well-calibrated application of it. Therefore, the parallel *phenomenoscopic analysis* conducted here of some of Zeno's and Einstein's thought experiments, has the precise aim of bringing out what is lacking in their albeit significant elaborations, so as to attain an organic balance between the seemingly preeminent logical or theorical component and the visual-perceptual component, also present. The most surprising aspect to emerge from this phenomenoscopic analysis is that a certain imbalance is attributable not only to the preponderant role assigned to the first of the two components, but also to an insufficient focus on, and consequent insufficient development of, the second, which may, at least to some extent, account for the greater importance given to the first.

The instrument that seems suited and, indeed, indispensable to redress the said imbalance, can indeed be the "intravisible" (or glimpsable). This little-used term describes the factor capable of producing an organic integration within phenomenal events between their physical and metaphysical meanings, not visually perceptible *per se*, though imaginable, and their

"perceptual visivations," which generate their actual appearing. The *Intravisible* takes on different shapes and forms in the various fields: phenomenal, physical, metaphysical, biological, artistic, religious, etc. But, in this context, we will only deal with the metaphysical, in which the philosophical approach and the scientific are one, to a considerable extent, linked and intertwined. The aforementioned Zenonian and Einsteinian thought experiments prove this in an exemplary way, not least because the *intravisible* is clearly identifiable there.

A more theoretically and historically complete exposition is to be found in a recently published essay,[1] to which we must return, from time to time, for the theoretical and/or historical integration (in Notes and Figures) of some of the more relevant and complicated points—so as to permit a simpler and perhaps a clearer explication of the theoretical implications of a general nature which are most significant from an epistemological point of view, common to both the philosophical and scientific approach.

THE INTRAVISIBLE IN THE "ACHILLES" PARADOX

We will begin with Zeno's well-known and stimulating paradox, the kinematic paradox of "Achilles", which lends itself particularly well to a specifically phenomenal or "phenomenoscopic analysis."[2] It is thus formulated in the Aristotelian version: "This [paradox] amounts to this, that in a race the quickest runner can never overtake the slowest, since the pursuer must first reach the point whence the pursued started, so that the slower must always hold a lead" (*Physics*, 239 b 23).

The diagrammatic visualization in which Zeno shows this logical description of the tortoise (T) being chased by Achilles (A) is represented, as we know, by a path divided into a potentially infinite series of increasingly smaller space-time parts, one by one covered by A in his pursuit of T. The sum of this infinite series, with the application of infinitesimal calculus, is generally regarded (albeit with some reservations linked to the notion and question of "infinity") as the *mathematical solution* to the paradox. But it also implies—in relation to this very question—the problem of its empirical feasibility and consequent visual perception, which were proved to be impossible, for example, by Max Black's thought experiments with the so-called "infinity machines."[3] Black therefore ascribed, in this regard, no less

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[1] G. Derossi *L'Intravisibile. Saggi di filosofia sperimentale: analisi fenomenoscopiche*, Mimesis, Milano-Udine 2024.

[2] See ibidem, pp. 59–100.

[3] For the main interpretations of the "*Achilles*" examined from a "phenomenoscopic" perspective, see op. cit., pp. 61 ff. It should be noted that, both the present treatise and the op. cit., make use of acronyms (e.g. *RVM* for *Relative Velocity between Movable Objects*), and conventional abbrevia-

value to a simpler mathematical solution, unaffected by the problem of infinity, it being based on the relative velocity (*rvm*) of A with respect to the velocity of T. However, in relation to this "mathematical solution", he expressed an even more radical reservation, namely that, while undeniably determining in numerical terms *where and when* A reaches T, it does not demonstrate *that* A reaches T; in other words, it does not show the "phenomenal solution" which could really demolish Zeno's visualization, which presents itself as a *phenomenal* representation. However, the "analytico-linguistic" solution which he offers as an alternative, already problematic in itself, is likewise refuted, as Black himself recognizes, by a simple phenomenon such as the fact that a ball stops bouncing on the ground in a finite time.

At this point it may appear both singular and significant that Black—and with him the majority of interpreters—while taking into account the aforementioned numerical expression of the simpler and indisputable mathematical solution, did not *glimpse*, and hence did not take into account, the implicit perceptual "visivation." It is here that we encounter, not just ideally but concretely, the "*Intravisible*" and the reason for its name: by and large, the key factor in the chasing-catching up phenomenon was not *observed* because it is not *directly* perceivable "on the surface" as an immediate datum; it is, however, *indirectly* perceivable, *deep* under the surface by which it is concealed or, rather, semi-concealed. It coincides with that very *rvm*, computed, given that it is easy to calculate—but not *visibilized*, because it is not so easily *observable*,[4] though it is *logically* admissible, since it is by no means contradictory to *think* that A has two speeds simultaneously, one in relation to the path (P) along which he is chasing T (e.g. at a velocity of 10 m/s) and the other in relation to T itself (which e.g. has a velocity of 1 m/s with respect to P)—so the velocity of A relative to T is 10 – 1 = 9 m/s. Thus logico-mathematical "thought" deduces and calculates in perfect coherence the "numerical essence" of the *observed phenomenon*.

But what is its visual-perceptual essence? It is not *directly visible*, nor does Zeno's presupposed and superimposed visualization make it so. A's velocity in relation to P is visible, but his velocity in relation to T is not—it would be so only if the *path* covered by A at that speed were visible. This other path, different from that on P, is not seen, either because it is not there or because it is hidden by P. But it *must* exist, otherwise A's velocity with respect to T would not exist either, and its existence is mathematically and logically proven.

This raises a fundamental epistemologico-ontological problem, which concerns the *ontic correlation* between logico-mathematical indication and perceptual visivation. Their *proven* correlation ensures that the first *indi-*

tions (particularly in mathematical formulas) which, without altering the content, can facilitate its interpretation.

4 See op. cit., pp. 66–67.

cates the real existence of the phenomenon (in this case, the pursued being reached by the pursuer thanks to his twofold speed, in relation to P and to T), and the second makes *visible*, and therefore *knowable,* the factor that makes the realization of the phenomenon itself possible (in this case, the *increase* in time, necessary and sufficient for A to catch up with T). In fact, it is the infinite progressive reduction of time, visualized by Zeno with his division of the course on P, that constitutes the seemingly insurmountable obstacle (highlighted by Black) that prevents A from reaching T. Therefore, it can only be overcome by demonstrating that the Zenonian division can and must be removed, to be replaced with another compound of spatio-temporal segments, and A's corresponding steps, sufficient and constant in measure (or, in any case, of the fore-seen duration).

But now another crucial problem arises, implicit in Black's interpretation. On the one hand, he notes that the mathematical solution based on A's velocity with respect to T's velocity is equivalent to that based on infinitesimal calculus, though his reasoning here is *not applicable to the sum of infinite series*. On the other hand, however, he does not explain the logic of this reasoning—logic that of course must be different from that of infinitesimal calculus. Yet it does not appear to be so, since for Black the problem of the sum of an infinite number of terms"[5] remains unresolved. He, too, does not seem to have glimpsed—although he got close—the *perceptual* reasoning inherent in mathematical computation. The greatest obstacle to the vision of the other "logic", the visual-perceptual one, seems to be the point of view generally held as essential—namely the one imposed by Zeno's visualization as reported by Aristotle—according to which A, *before* reaching T, must overtake *one after the other* all the increasingly smaller advantages in the infinite series that T gains in its escape. Any solution therefore must respect this *complete* spatio-temporal succession in A's chase.

The previously envisaged "phenomenal visivation" however drastically modifies the compact articulation established by Zeno's visualization and maintained in its transposition to infinitesimal calculus—therefore they are mutually incompatible. Thus emerges a problem of epistemologico-methodological nature that must be clarified.

In the example presented above, it actually transpired that on the first 10-meter section, due to the effect of A's velocity with respect to T, which is 9 m/s, his velocity relative to the ground is not 10 m/s—which would be the case if he were running alone—but is instead *temporally* different: not 1 s, but $1.1 \div 9 = 1.1$ s).

Therefore, A *must* complete, on the ground where the pursuit takes place, a path, not of 10 m/s, which is the "advantage" or head start granted to T,

[5] See ibidem, p. 100.

but one of 1.1 s, therefore also *spatially* greater—at the end of which he can reach T.

Zeno's visualization, however, requires that *first* the goal of the advantage be *reached* by A, i.e. all ten meters of his path on P. Now, taking into account this spatio-temporal increase, it is certainly *attained* by A but not strictly *reached*. Therefore the phenomenal visivation is incompatible with the metaphysical visualization, as it demonstrates its non-correspondence to the *intravisible* appearing of the phenomenon.

In this case too, the basic reference criterion is that of *completeness*. This is clearly lacking in the metaphysical visualization, which reveals itself as incongruous because, while on the one hand it places a close space-time correlation between the two runners—which necessarily implies the unavoidable factor of the relative speed between them—on the other hand it does not even permit it to be glimpsed, since it represents both runners as if they were running alone.

Ultimately, *phenomenal visivation* is incompatible with Zeno's *metaphysical visualisation* because, unlike the latter, the former is compatible both with the phenomenal appearing of the chasing-catching up phenomenon and with the *non*-infinitesimal mathematics in which it is *intravisible*—and hence susceptible to being made *visible* together with the *visibilized* phenomenon.

THE INTRAVISIBLE AND THE RE-VISION OF THE PARADOX

Such a decisive and conclusive substitution as that of the *metaphysical visualization* with the *phenomenal visivation* can only be performed on the basis of a spatio-temporal factor operating *within* the phenomenon. For this very reason, however, it is not—as we have noted—immediately visible, and this is proved by the fact that generally it has not been seen or even glimpsed. We must therefore make it visible "by bracketing," that is to say, by neutralizing without eliminating, the superficial datum that conceals it, namely the *path P* along which A is pursuing T.

Referring the reader to the aforementioned text[6] for a detailed demonstration, here it is sufficient to convey the final result mentioned previously, namely that, precisely because A can only run on P at his speed of 10 m/s, he can take advantage of the *time increment* implied by his *rvm* of 9 m/s relative to T, lower than his speed of 10 m/s relative to P. It is this very increment that allows him to *reach* T. In his race on P, as observed, A should have two speeds on that same path, but two speeds require two different paths; and since he cannot modify his speed relative to P to increase it, he

[6] See ibidem, especially, pp. 181 ff.

must—as demonstrated in the mentioned "visivation"—have an increase in time precisely because the *rvm* is necessarily operational (in the manner indicated).

The said de-monstration highlights the fact that this factor, though not immediately visible, already is so, albeit to a limited extent and in a limited manner, on close observation, which, if duly supported by a specific device, becomes entirely clear and indicative. In this way the determining spatio-temporal factor, although not fully visible, is not completely invisible either: it is therefore a visible *synthesizer* which resolves the visible-invisible dialectic in the synthesis of the "intravisible" (a perceptual dialectic, not a conceptual one like Hegel's). A can thus reach T without having to perform a finite sum of infinite steps or jumps—but by taking regular steps instead, or even irregular ones, provided that they are accomplished within the complete duration established by the *rvm*, *visibilized* with the said device in a time that is structured evenly. So we can finally reply in the negative to the nagging question: "Is A still running?"

The omission of the intravisible temporal factor does in fact invalidate the Zenonian visualization, since it proves that it lacks the necessary *completeness* in terms of basic phenomenal data—which is an indispensable epistemologico-methodological requirement—as mosaic tiles are for the composition of the entire *form*. This incompleteness theoretically foils the attempts to refute it without first duly integrating it—as, indeed, the still non-finite series of even more sophisticated interpretations attests.

Only with the insertion of the missing intravisible piece is it resolved, since its form, not consistent with the *real* one, is *dissolved*. The *principle of completeness* implies the *principle of reality* and this, in turn, implies the *principle of phenomenal visibility*, achievable with the kind of *observation* capable of discerning not only the *immediate visible* but also the *invisible discerned in the intravisible*. Only thus can the *interpretation* become a "visivation of the essence" of the phenomenal object and not a mere vision of the essence, similar to that of the phenomenological pure object. It is on the basis of this, therefore, that one could respond in the negative to the nagging question mentioned previously.

However, we must first address a question which demands an answer on the basis of that very principle of completeness. That is, one can ask oneself whether Zeno's *visualization* is applicable to the *visivation* that takes into account the *rvm* between the speed of A and that of T.

In relation to our example, the Zenonian diagram merely *represents* that, while A is completing the first stretch of the spatial "advantage" or head start granted to T, the latter covers a shorter stretch, and so on *ad infinitum*, because the *swift-footed* A is *faster* than T—but not fast enough to reach it. However, their respective speeds are not specified, and neither is the speed of A relative to that of T. Consequently, the time taken up by this first phase

in A's chase also remains undetermined. Ergo the physico-mathematical determination of the *phenomenon* is missing. But the visual-perceptual determination is also lacking, because the visualization of the correlation between the respective movements of the two runners is not provided or even roughly indicated.

The void left by these two essential components of the *phenomenon* is filled only by the logico-metaphysical component, which *pictures* the *factual*—but not the *phenomenal*—succession of the various spatial stretches covered little by little by A and T in the same time frames, setting aside the conditions and modes of their phenomenal manifestation—whose veracity is also subject of the mental experiment. Due to the blatant deficiencies reported, the mental experiment proves unsuitable since it demonstrates nothing but an *imagined, abstract, appearance* of the *concrete, perceptual phenomenal appearing*. Such incompleteness renders inevitable and irreparable the artificial articulation of the phenomenal event, which is proved finite already *in its initial phase* by a rigorously complete mental experiment. Indeed—as we have de-monstrated—the time gained by A thanks to his *rvm* with respect to the speed of T on the first stretch of the advantage granted to it, allows him to catch up with T during the *first* leg of the chase.

In fact, the infinite articulation must not—because it cannot—even begin because, if it does, it has no end. And A's reaching T is possible and real precisely because he, on account of his being not only swift-footed but also—so to speak—"long-footed," clears with a single leap (made of ten longer steps) *both* the first stretch of the head start *and* the one gained by T. Zeno's "metaphysical visualization" therefore proves inapplicable to the "phenomenal visivation" because they are mutually heterogeneous: the latter, in turn, is not compatible with the former, which is constitutionally incapable of even letting us *imagine* the intravisible inherent in A's rvm.

A definitive revision of the paradox, then, ultimately implies a *complete*, organic integration of all the components that are in their different ways instrumental in *showing*—and thus making *known*—the *real* phenomenon. They are: the basic mathematical component which indicates it, the logico-linguistic component which codifies its meaning, and the visual-perceptual component which makes it *appear* by means of the "*intravisible*" factors rendered visible in its *visivations*. *The mathematical indication highlights the rvm by measuring it*; the *logical interpretation* deduces that the *rvm* can and must be decisive as a *temporal integration*; and the *comprehensive visivation* shows, on the one hand, the incompleteness of Zeno's visualization—which makes the paradox unsolvable—and, on the other hand, the completeness of the "visivation," which, by supplanting the former, translates the sophistic paradox into the intravisible and visible terms of a rationally solvable *problem*.

The methodologico-epistemological principle highlighted by this revision is that, ultimately, it is not up to metaphysics *alone* to save the phenomena, and the same goes for mathematics, physics, semantic analysis or perception, but it is up to their mutual and complementary understanding brought about by the *visivation* of the *intravisible essence* of *phenomenal reality*.

THE INTRAVISIBLE IN EINSTEIN'S SPECIAL THEORY OF RELATIVITY

We find the *Intravisible* in the form of *rvm* in some of the "demonstrative" thought experiments visualized in Einstein's *Special Theory of Relativity*.[7] This should not come as a surprise, since they also present the fundamental problem of the relationship between a constant velocity, like that of light—which is indeed so, not only de facto but also in principle—and the velocity of related reference frames (*rf*) at rest and in motion. Naturally, the historical and theoretical differences compared to Zeno's metaphysical approach—as gleaned from the recently examined *Achilles* paradox—are evident; but for this very reason it can be even more significant to draw a comparison on the problematic nucleus which both approaches, nevertheless, have in common and which entails important epistemological and metaphysical implications that in Einstein's theory are revealed even more in depth.

Referring to the aforementioned text for the historical and epistemological contextualization, we will simply recall, in brief, some well-known points of the problem that led Einstein to develop and demonstrate the theory of time relativity via the thought experiment method.

The experimental discovery of the inalterability of the speed of light had called into question the two Galilean principles that, since Newton, had formed the foundations on which modern physics is based: the principle of inertia and the principle of Galilean relativity. The first appeared to be incompatible with what Einstein called the postulate of the constancy of the speed of light with respect to *rf* in motion. This incompatibility seemed to inevitably involve the second principle as well, although even according to him it had always proved to be reliable. Taking this into account, he sought a theoretical solution that would demonstrate the possibility of reformulating the Galilean principle of relativity in such a way as to make it compatible with the aforementioned postulate. He was facilitated and encouraged in this arduous endeavour—as he himself recalled—by the mathematical solu-

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[7] See A. Einstein *Über die spezielle und allgemeine Relativitätstheorie (gemeinverständlich) (1916). Relatività. Esposizione divulgativa*, trans. by V. Geymonat, Boringhieri, Torino 1964, pp. 19 ff.

tion formulated in the Lorentz transformation. Hence, compatibility already seemed *de facto* guaranteed; but not "by right," that is, with regard to what Einstein termed its physical meaning.

Here we return to the distinction already made—as one may recall—by Black in relation to the mathematical solution of the *Achilles*, between ascertaining the *what* and demonstrating the *how*, necessary to the *knowledge* of phenomenal events in physics no less than in metaphysics. In this regard, Lorentz's mathematical formulation brought to light a factor not easy to comprehend within codified theoretical schemes: the *increase in time* measured by a clock in motion as a consequence of being in such a state. After lengthy reflections on the subject, also stimulated by the analyses of Ernst Mach, Henri Poincaré and Michelangelo Besso in particular, it dawned on him that time "flows" more slowly in moving *rf* than in stationary ones. However, the demonstration of the corresponding physical meaning was not to be obtained with a more sophisticated logico-mathematical elaboration, which would only have reconfirmed the *fact* without clarifying its *phenomenal visualization*. Thus, the demonstration could only be conducted with the methodical use of the thought experiment, a specific instrument qualified to make manifest the non-superficial, real, phenomenal appearing.[8]

Admittedly, it is clear that a method in which mathematical, logical, linguistic and phenomeno-perceptual "meanings" coexist, can only be applied by means of specifically perceptual-visual experimentation (and, in this sense, mental). Indeed, it is not surprising that this method has been and continues to be applied both in the scientific field and in the philosophical field to *matters of principle*.[9] Einstein was well aware of this, so much so that it became—as remarked by Jammer—his favourite demonstration technique (although, it was actually the only alternative). It is, however, a *complex* method precisely because of the co-presence of many components, each far from simple, which must be correctly coordinated in order to be effective. The use Einstein made of it in relation to the specific problem in question is marked by the correlation between the *mathematical* component and the *phenomeno-perceptual* component. And it is exactly this correlation that our phenomenoscopic analysis addresses.

The mathematical expression of the aforementioned increase in time in *rf* in motion—derived from the well-known Lorentz transformation—does in fact imply, even if only *in nuce*, the *phenomenal visivation* to which the *physical visualization* (or physical meaning) should at least partially relate. We already identified this correlation in the mathematical solution of the Achilles as the expression of the *rvm* between A and T. However, this solu-

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[8] See ibidem, pp. 145 ff.

[9] Mach in particular is credited with having appreciated and developed it historically and methodologically: see G. Derossi, op. cit., pp. 101 ff.

tion does not make the correlation *visible* in the perceived event, so it is necessary to obtain a "visivation" of it by highlighting the *intravisible* temporal path. The *visivation* method is actually implemented in a procedure of explicitation: the mathematical basis, which certifies the existence of the phenomenal datum (in this case the increase in time mentioned earlier), *already implies*, by means of the "sign system" of mathematical symbolism, the *primary* reference to the phenomenal datum.

This *symbolic reference*, however, does not show, that is, it does not concretely and effectively make known, the *essence* of the phenomenon, which is only calculated and, at best, *intuited* but not *perceived*. We must therefore proceed to what Husserl calls "the vision of the essence," which, however, must not be merely "ideal" or "idealizing" as it is for Husserl, but must instead visually adhere to the phenomenal datum symbolized in mathematical language (in whose "characters"—as Galileo said—the physical world is "written"). This reciprocal integration involving the "calculating" mathematical expression and the verifying perceptual visivation could indeed be the cornerstone of the special theory of relativity, as it is qualified to insert the latter in the system of physical theorization in a coherent way.

However, Einstein follows the reverse order: he starts from the theories concerning the specific time problem related—as observed by Jammer—with the procedures of synchronization of clocks both stationary and in motion (procedures including those devised by Poincaré with thought experiments that predate Einstein's). These procedures then require other ones in order to ascertain the simultaneity of distant events. *Simultaneity* is therefore postulated by Einstein as the *essence* of time, the visualization of which is provided, in the following phase of the investigation, via thought experiments in which the visual-perceptual component is acknowledged and recognized as indispensable, although it is not always implemented with the necessary completeness, inclusive of the intravisible elements—as was already the case in Zeno's visualization of the "Achilles."

Here we touch on a crucial point of the epistemological problem at hand. As in the case of the "Achilles", in this case too we can and must ask ourselves, first of all, why it is necessary to include, in the visivation of simultaneity, the *intravisible factor* of the *rvm*. The answer is analogous to that given regarding the Achilles: firstly, its operational role in the events considered is logically and, above all, perceptually confirmed; secondly, for this very reason, it *must* be taken into account in the mathematical formulation derived from the Lorentz transformation, precisely because it refers to a real *phenomenal* factor. As we have already noted, in the language of mathematics the *meaning* is paired with a *reference*, that is to say not an ideal element but a real one. Thus, there is a need for a phenomenoscopic analysis capable of clarifying this, by making it phenomenally visible, the physical meaning

which in mathematical language is expressed with signs or characters that *indicate it truly but do not indicate it completely, in a cognitive sense.*

For Einstein too—this must be duly stressed—*knowledge of reality* is possible only by moving from the symbolic language of mathematics to the visual language based on perceptual observation, which renders the physical meaning visible. However, he does not seem to consider the need for this transition to be *continuous*, i.e. that in it an organic nexus should be maintained not only with the quantitative *indications* but also with the qualitative ones, already mathematically—and perceptually—acquired. Ultimately, the physical meaning is to some extent already *intravisible* in those indications, as we established with regard to the "Achilles."

And, indeed, also in this case the intravisible factor can be detected in the *rvm*, acting, in this instance, not as *velocity* but as a *time* increment. It is here, however, that we encounter the crucial critical point of Einstein's theory: Einstein did not, in fact, *glimpse* this function, namely the veritable "phenomenal transformation," within the *rvm*, *of velocity into temporality*, whose increase *appears* in the corresponding spatial elongation. He did not glimpse it because he did not see the possibility of such a lengthening of the path in space.[10] In paragraphs 6 and 7, referred to in the footnote, he takes a clear stand on the issue with some simple thought experiments in which he visualizes the addition and subtraction between *c* and *v*, the velocity of a moving carriage with respect to a stationary platform. If, for example, the carriage is travelling at velocity *v* with respect to the platform, and moving in the same direction as a ray of light *R*, which is moving at v = c with respect to the platform, the *v* of *R* = *w* relative to the carriage is: w = c – v. Einstein concludes that "the velocity of propagation of a ray of light relative to the carriage thus comes out smaller than *c*."

This result is in conflict with the principle of relativity,[11] a conflict which is resolved by the theory of time relativity, based on the demonstration conducted with the well-known thought experiment that shows the different perception of the simultaneity of distant events (like two flashes of lightning striking) as experienced by an Observer standing on a stationary railway platform, compared to that of an Observer sitting in a train which is in motion with respect to that very platform.

The previous, simpler, thought experiment mentioned is analogous to that of the Achilles: instead of A (Achilles), there is the ray of light R, which has a higher *v* than that of the carriage in motion or a person transported by it, who can replace T (the tortoise). The corresponding phenomenoscopic analysis is therefore also analogous. Momentarily "bracketing" the postulate of the inalterability of c, the decrease in w = c – v is mathematically certain;

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[10] See A. Einstein, op. cit., par. 6 and 7, pp. 33–38.
[11] Ibidem, p. 36.

but its physico-phenomenal meaning, attested by perceptual vision, is not. Indeed, just as in the "Achilles" the only visible course continues to be the path P on which A is chasing T, so the only route for R remains the platform, as Einstein clearly states.[12] But just as A cannot run on P at two speeds at the same time, so R cannot do so on the platform. One can calculate it, think it, speculate or imagine it—as Einstein does—but one cannot see it perceptually. Since it is a phenomenal event, that is, an event that *appears*, it is possible to observe it only by seeing it. This is what Merleau-Ponty calls "the primacy of perception"—which, by the way, he unduly absolutizes—in the *knowledge* of phenomena. Of course, this does not mean that the *real* reference to the *rf* of the carriage in motion is neutralized, but it is scaled down to temporal component of the v of R with respect to the carriage itself: as in the case of the "Achilles", it has more time to reach it and overtake it, precisely because it keeps its $v = c$ unaltered. This phenomenoscopic analysis therefore demonstrates that the problem of the alteration of c with respect to a moving *rf* thus is also scaled down; as is that of the incompatibility between the law of propagation of light and the principle of relativity in *rf* in motion.

THE LIGHT CLOCK (LC)

The problem of the increase in time, therefore, must and can be clarified by showing, in light of the previous elucidations, the *intravisible temporal meaning* inherent in the γ equation mentioned, from which it follows that "as a consequence of its motion the clock goes more slowly than when at rest."[13] The well-known light clock (LC) thought experiment lends itself particularly well to a "phenomenoscopic" take on the interpretation according to which time does not "slow down" or "dilate" but "increases."

Since it is analysed in detail in the aforementioned reference text,[14] we will simply highlight some points of particular epistemological importance.

The first point is that the thought experiment in question does in fact *show* this slowing of time, since it highlights how a stationary Observer O on Earth *sees* that the speed of the ray of light R, which oscillates bouncing back and forth between the two parallel mirrors AB of the "dial" of the clock of an Observer O^1 in a spaceship traveling through the cosmos, is lower than the speed seen by O^1 himself, namely c, in that very clock, which is in his *rf,* at rest *for him*. It is not generally observed, though, that O's vision is actual-

[12] "Viene lanciato un raggio di luce – lungo la banchina – la cui estremità avanza con la velocità c rispetto alla banchina stessa" (ibid. p. 35).

[13] Ibid., p. 55.

[14] G. Derossi, op. cit., pp. 186–192.

ly a "visivation" that *renders visible* the intravisible *rvm* between the velocity *c* of R and the velocity v of the spaceship. In U. Forti's[15] example, the velocity of the spaceship is v = 676, thus, applying the *γ* equation, we have: √1 – 675 ÷ 900 = √1 – 0,75 = √0,25 = 0,5 and 1 ÷ 0,5 = 2, which is the increase in time. The temporal component, namely the *rvm* of 900 – 675 =√225 = 15, is expressed without revealing the *visivation* necessary not only for the phenomeno-perceptual verification but also to *let us glimpse* the change in rhythm, that is, the slowing of the oscillations of R, visible on the AB dial: a change in rhythm that thus can be *calculated* but also *seen*.

Here, however, we encounter a seemingly insoluble paradox: the *vision* of the slowing of time in the spaceship is caused by the fact, mathematically expressed in *γ,* that R is seen by O (i.e. from Earth) to be bouncing back and forth between the two mirrors with *rvm* equal to 900 – 675 = √225 = 15 rather than with c = 30, which obviously remains unchanged in the terrestrial clock. In the calculation the *rvm* remains semi-concealed, but not in its physico-phenomenal reality, in which it does actually *appear or can be made to appear*—although it should not be *seen*, except as unaltered speed of light.

The solution to this paradox is analogous to that of the "Achilles". The reduced rhythm of the *rvm* with which R bounces back and forth between the two mirrors in motion is simply the *intravisible appearing,* on a shorter, forced route, of its true motion along the *invisible*, longer diagonal route in space, which corresponds to the horizontal course of the spaceship, which is at the root of it and is thus taken into account. On the shorter, vertical AB "dial" the rhythm of the bounces must necessarily slow down, to coincide with that of the *rvm*. This slowing is therefore *seen*, but *in as much as* it makes the *intravisible temporal increase* appear, of which the *rvm* is the *visivation*.

The real appearing of the intravisible factor is, here, as evident as it is necessary in order to find a solution not only perceptually but also logically and mathematically adequate. Indeed, even the mathematical expression can be simplified, so as to stop it from hiding the intravisible temporal meaning of the *rvm*, since the same result can be achieved simply by means of the direct ratio c ÷ vrm as in the aforementioned example involving the LC: 900 ÷ 225 = √4 = 2 (the temporal increase); or, in the case of a spaceship velocity of 25^2 = 625 and mrv = 900 – 625 = 275, we have: 900 ÷ 275 = 1.8 (the same time increase obtained with γ) and so forth. The intrinsic inherence of visual demonstration in mathematical expression (and vice versa) is thus confirmed.

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[15] See U. Forti, *La teoria di Einstein*, Nuova Accademia, Milano 1961, pp. 101 ff. (As in other cases, some numerical simplifications are adopted in this analysis)

The *phenomenal meaning* of the increase in time intravisible on the AB "dial" of the "light clock" seen in a state of motion by O on Earth, where he is in a state of rest, is similar to that observed in "Achilles" *pursuit* of the tortoise. This increase allows the ray R to complete the oscillation that allows it to *reach* B; and this wider oscillation also measures the time taken by the same AB "dial" in its inertial motion on the same course as that of the spaceship, namely the reference frame in motion by which it is carried. O^1, *within it,* sees himself and AB at rest, so he is not in a position to measure the space-time parameters of a motion he cannot see: his clock, for him, *only marks time*, i.e. the *passage of time* in a state of rest.

It does, however, also *measure* the time the spaceship requires for its motion, and this measurement is *glimpsed by O on Earth* in the same identical measurement, *visible* in his AB dial, identical to that belonging to O^1. This is the *visivation* of the corresponding oscillation registered in the identical clock within the spaceship—whose phenomenal reference (*its* motion) is *invisible* for O^1 but *intravisible* for O by "bracketing" the *vision*, *which he alone sees*, of the smaller and slower oscillation that appears on the AB clock belonging to O^1.

Ultimately, it is not the *rhythm* of time that differs in the two clocks and in the respective reference frames, but rather the *measures* of time, *invisible* and *intravisible* respectively—and the latter, via the mentioned "bracketing," "visibilize" the former.

THE TEMPORAL INCREASE IN MUONS IN MOTION

A no less significant confirmation is inherent in the well-known experimental verification on the different lifespans of *Muons,* both stationary and in motion.[16] Similarly to the spatio-temporal divisions generated in previous thought experiments, in this case we can create an empirically verifiable one of the 4500 route completed by a Muon M and divided into ten stretches: $4500 \div 10 = 450$. Each section is covered at a v of 297 in about 1,5; therefore, $1{,}5 \times 10 = 15$, which is the lifetime of a stationary Muon divided into 10 periods of decay. Assuming, with Cortini, that the v of the Ray of light with which the time of the event is measured from Earth is 300, we have: $\gamma = 1 \div \sqrt{1 - 0{,}99} = 1 \div \sqrt{0.001} = 1 \div 0{,}1 = 10$. Now, the same result can be obtained simply with the following division: $300 \div 3 = 100$; $\sqrt{100} = 10$.

This comparison makes it clear that the codification of the γ equation derives from the need to avoid any reference to the *rvm* between c and the v of the Muon ($300 - 297 = 3$), which would be theoretically inadmissible. This is

[16] For its specific historico-theoretical context, see G. Derossi, op. cit., pp. 192–201. The simplified numerical indications (measured from the Earth's *rf)* are those adopted in the treatise by G. Cortini, *La relatività ristretta*, Loescher, Torino 1979, pp. 30 ff.

achieved by replacing the c÷ vrm ratio with the c ÷ v ratio. This way the prohibited subtraction between c and rvm is avoided, substituting it, in our case, with that between t =1 and t = √1 – 0,99 = 0,01, whose square root is 0.1. The resulting time is precisely the intravisible t in the rvm of 3 (see above), which is made visible by the time taken by the Muon to complete the entire 4500 route: at v almost equal to c (297), it remains unscathed and therefore can run its course—hence time does not dilate in the initial 4500 section, but it is added to such a degree as to allow the completion of the sections after the first.

THE RELATIVITY OF SIMULTANEITY

Einstein's epistemico-methodological framework is different, geared towards a clearer mutual distinction among the following roles: logico-mathematical, physico-theoretical and visual-perceptual. He openly states that the compatibility of the law of propagation of light (that is, of its inalterability) and the principle of relativity is evident from *an analysis of the* physical *conceptions* of time and space, which enables us to reach "a *logically rigid* theory."[17] Leopold Infeld, in turn, points out that "a subject on which volumes were written by philosophers has been changed by considerations arising in the field of physics."[18]

In fact, Einstein did not limit himself to a strict analysis of conceptions of time and space in his review of the conceptions of them in modern physics. On the contrary, he not only claimed but also proved in a clear and precise way (also under the influence of their Machian theorization, of an empirio-criticist mould) the need to corroborate this analysis with a fitting empirical verification, driven by the targeted use of specific thought experiments. Nevertheless, his methodology, though incisive, failed to "espy" the *intravisible prefiguration inherent in mathematical formulas*—and, in particular, in the basic one of the Lorentz transformation, coinciding with the intravisible phenomeno-temporal factor. The correct visivation of it would have clarified, more successfully than analysis of conceptions, the apparent enigma of the increase in time in moving *rf*: it would have done so adhering more closely to the real phenomenal appearing of its physical meaning.

Consequently, the empirico-perceptual verification of relativity inherent in the fundamental conception of *simultaneity*—considered the essence of time—and presented in the crucial thought experiment dedicated to it, does not appear conclusive because—as in Zeno's visualization of "Achilles" chase—it is incomplete, specifically—like the other before this—due to the

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[17] A. Einstein, op. cit., p. 37 (my italics).
[18] L. Infeld, *Albert Einstein*, Einaudi, Torino 1962, p. 40.

absence of precisely that intravisible temporal factor. We will focus our phenomenoscopic analysis on this decisive point. This absence is caused by an asymmetric correlation between the two observers, O and O¹, who we previously found, respectively, in the stationary reference frame of a railway platform and in the reference frame of a train in motion on tracks parallel to the platform. Referring the reader to the mentioned text[19] for a more detailed examination—as well as for other important aspects of this crucial mental experiment. At this point it is necessary to devote a more thorough visual analysis to the said correlation between O and O¹, of a relativistic nature.

As strongly emphasized by Infeld[20] among others, the correlation must be *fair,* so the points of view of both Observers—O at rest and O¹ in motion—can and must be constantly and mutually compared. In the mental experiment in question, however, the point of view of O, *at rest on the platform* (P), happens to be adopted every time—as explicitly stated in a side note[21]. Indeed, all that is "taken into account" is what O *sees*, *looking* at the events that are happening *both* through his reference frame P *and* through O¹'s reference frame in motion on the train (T): in the first, lightning strikes simultaneously; in the second, O¹ is reached *first* by the ray of light R', towards which the train is moving, and *then* by the ray of light R, which reaches O later.

All these events are seen by O *directly* from his rf P. In addition to these, however, he is credited with the perception of another event that he does not see directly: namely the fact that O¹ *sees the non-simultaneous arrivals* of the rays of light *"first-hand"*—which is impossible because, since O¹ sees himself at rest within T and sees the rays R and R¹ both moving towards him at a speed equal to *c*, he cannot fail to see the said arrivals as simultaneous, just as O sees them on P. Of course, as his point of view is directed inversely, it is now he (O¹) who *sees—but on his own rf T—that O does not see* the simultaneity of arrivals: but this does not authorize him to attribute O with a vision that in reality he does not *directly* have—just like, in the previous analogous situation, the vison was not O¹'s own. This is the mainstay of the demonstration of the perceptual-visual relativity of time; hence it must be analysed by means of a detailed examination of the text in which Einstein draws conclusions based on the demonstration itself.

Having assumed that O¹, if he were sitting at the midpoint M¹ of the train at rest rather than in motion, would be reached simultaneously by the rays, he points out that "*in reality* (*considered with reference to the railway embankment*) O¹ is hastening towards the beam of light coming from B, whilst he is riding on ahead of the beam of light coming from A."[22] In other

[19] G. Derossi, *L'Intravisibile*, cit. p. 163 ff.
[20] L. Infeld, *Relatività ristretta*, cit., p. 43.
[21] A. Einstein, *Relatività. Esposizione divulgativa*, cit., p. 43., n. 1.
[22] Ibid., p. 44 (my italics).

words, the reality is that seen on and from the platform, naturally because it is at rest. This is a crucial point: *saying* that the platform *is* at rest has *physico-conceptual meaning* on account of it being *considered* at rest. However, it follows that this *saying* has *physico-phenomenal meaning* only if its state of rest is *seen directly by an Internal Observer, namely O*. Thus, *in reality* (considered with reference to the train, which O^1 sees at rest, as if it were stationary), O sees the two rays arriving simultaneously. In general, the fact that an Observer *sees* himself at *rest* within a moving reference frame cannot be *seen directly* from another reference frame at rest related to it; but for this very reason it can and therefore must be *glimpsed* from it, and vice versa. This *glimpsing* can *show* the *reality* of what is glimpsed, making it *visible* by "bracketing" any reference to the events seen by O *from the platform*.

This distinction between *direct vision* and *indirect vision* does not appear in the Einsteinian visualization of simultaneity: O^1's point of view is taken into account not directly, but through O's point of view. We have now arrived at another crucial step: to be able to see what O^1 sees first-hand *inasmuch as he perceives it*, it is necessary for it to be *glimpsed also* from his own point of view. The *intravisible* that thus presents itself to us is quite different from O's vision because it *shows* us, on the one hand, that inside the train in motion O^1 actually sees himself at rest; and, on the other hand, that he sees the speed of the rays equal to *c*, remaining unaltered. Consequently, he also sees the simultaneity of their arrivals, since he finds himself just opposite O.

Generally, this drastic difference between the two visions is simply ascribed to the fact that O's point of view is *replaced* by that of O^1. Of course, this way the two points of view are recognized as equivalent (equal), but only insofar as it is irrelevant if, in turn, one is unilaterally predominant or the other one is. Conversely, the said difference allows us to glimpse that, not in turn but *every time (i.e. always)*, the two points of view are equally operative because they are equally *conditioned*.

Certainly, *from O^1's point of view* the train is the reference frame at rest and the platform is the reference frame in motion. However, this does not mean that the train is to take on the role of a privileged reference frame instead of the platform, because in reality *both are simultaneously non-privileged*, as are simultaneous and equal the respective visions, on the part of O and O^1, of being in a reference frame at rest. The truly "privileged" role as *conditio sine qua non* of the visual perception of simultaneity ultimately belongs to the *state of rest*, for whose realization there is also a *conditio*, that of *being seen*, which is on the basis of a third *conditio*: whoever sees it needs to be *inside* the reference frame.

Only if these conditions are met can O, O^1 or any other Observer, in whatever reference frame, see the simultaneity of distant events. Conse-

quently, whoever is looking at the related reference frame from the outside can see neither the state of rest nor the simultaneity of events seen by who is inside. This is why O¹ cannot help but see the opposite of what O sees, and vice versa. And, above all, it is because of this that seeing from the outside constitutes the *determining* point of view for physico-mathematical theorization. This way, though, it is also treated as *privileged*. This is essentially the underlying problem which presents itself as a paradox.

Einstein, in fact, "absolutizes" O's point of view from the platform by explicitly taking it as evident proof of O¹'s failure to perceive the simultaneity of the arrivals of the two rays, on the basis of the visualisation of the event realised in the well-known diagram, which represents—as previously noted—that at the moment of emission of the rays the point M¹ on T, which coincides with the point M on P, "moves towards the right in the *diagram*" (see Fig. 1) with the speed *v* of the train.

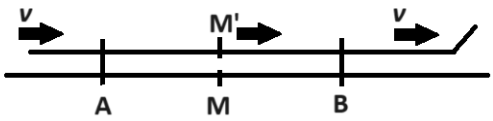

Fig. 1

"If an observer sitting in the position M¹ in the train did not possess this velocity, then he would remain permanently at M, and the light rays [emitted by the flashes of lightning A and B] would reach him simultaneously"[23]—which, however, cannot happen due to the motion of the train. Hence this constitutes an explicit admission of the *demonstrative* value attributed to this diagrammatic visualization of reality, which is—and this is an essential clarification—"*considered only with reference to the railway embankment*"[24] (that is, by the Observers on the platform who "take the railway train as their reference-body").

Let us now move from the *visualization of the diagram* to the *visivation of the phenomenon observed* from both points of view at the same time, consequently seen not only by O at M on P, but also by O¹ seated at M¹ in the train. O¹, *from his point of view, sees himself at rest*, and thus sees O, carried by the motion of P, moving towards his right (so towards the left in the diagram) with a speed v equal to that of T, which he sees at rest.

Therefore, to present the correct—that is, the *complete*—visualization of the P-T correlation, it would be necessary to *compare* the diagram drawn from O's point of view with the corresponding one drawn from O¹'s point of view. The choice to "privilege" the reference frame of the platform stems

[23] A. Einstein, op. cit., p. 44 (my italics).
[24] Ibidem, p. 43 (my italics).

naturally from *knowing* that, from a *physical* point of view, the train must be moving on the ground, and not vice versa. Even *phenomenal seeing*, also based on that same *knowledge* (specifically of the "principle of inertia"), implies the same vision, but directed inversely.

Of course, this way the two diagrams would appear equivalent, even if oriented in opposite directions; but this difference does not seem sufficient to favour one over the other—unless they were not observed simultaneously but in succession—as is generally postulated in an explicit or implicit way. It should be stressed that the said contemporaneity, being an indisputable *datum*, does not imply—as has sometimes been claimed—Newton's absolute time. If anything, this is actually presupposed by the thesis of the succession of the two visions (O's and O^1's), which entails that in turn each of them is the absolute" because one is exclusive of the other.

Naturally their contemporaneity and their consequent equivalence poses the problem of how it is possible to *demonstrate* that time "increases" in reference frames in motion compared to those at rest—if the former also appear at rest not only to *internal* observers, but also (albeit *in a different way*) to *external* observers who see them in motion.

In fact, the said motion only appears "on the surface" to external observers, while internal observers perceive their state of rest first-hand. But who sees *the real state*, the former or the latter? The answer to this crucial question can be given on the basis of the no less crucial visible-invisible distinction, which in turn is based—as pointed out in previous cases—on the distinction between *direct vision* and *indirect vision* of the appearing of events. Direct vision provides the immediate sensible datum that imposes itself on the percipient on the basis of the *conditions* in which he finds himself. Thus, O is in the condition of a state of rest that shows him O^1's state of motion, and *vice versa*. However, the latter is an *indirect* perception on O^1's part of his own state of motion, which he cannot see directly. So *O's condition of rest on the platform* constitutes—precisely because it shows T's motion—an *obstacle* to seeing the *state of rest* of O^1 within the train. Such an "obstacle" therefore represents a typical example of the *intravisible* in that, though hiding the vision that O^1 has of his own state within the train, it lets it *transpire in the vision of his motion*.

It is manifest that it is precisely this lack of *indirect vision from the outside* of O^1's state of rest that makes us *glimpse the direct vision* that he *must have* of it *inside T* and that he can observe "first-hand." Moreover, since O^1 with respect to O on P has, simultaneously, the same vision that O has with respect to him in T, the correspondence between the two *visions*, made visible by their respective *visivations*, is evident. *These* make it possible to render explicit the indirect visions of the state of rest of O and O^1 within their respective rf P and T by virtue of the simultaneous *indirect but transparent vision* of their states of rest and motion.

THE INTRAVISIBLE IN THE MÜLLER-LYER "GEOMETRICAL-OPTICAL ILLUSION"

The *intravisible factor* is operative in perception in specific ways; since we cannot provide a detailed exposition here, we will simply outline some guidelines which emerge from a summary comparison with and between two of the main perceptological theories that originated at the end of the nineteenth century and the beginning of the twentieth: the phenomenological theory of Brentanian origin (developed by the Graz School) and the experimental *Gestalttheorie* (developed mainly by the Berlin School, but with important offshoots in Padua, Trieste and elsewhere). An instructive example to introduce the theoretico-experimental approach of the first of these is illustrated by one of its most representative figures, the Triestine psychologist Vittorio Benussi.[25] He points out that the perception of the set of points visible in Figure 2 can occur in two different ways: with an intentional act (a term of Brentanian origin), analytical in character, or with a "gestaltic act." The first is produced by sensory stimuli originated from each of the points observed *separately* from the others. The second instead captures the *figure* of the parallelogram in which the points appear to be arranged, without receiving any sensory stimulation from it, therefore it cannot but be produced by a mental elaboration which could evoke Kant's *a priori* intuition, but it is not mentioned.

This distinction between "sensory representations" and "non-sensory representations" was criticized by the Gestaltists in particular by Kurt Koffka, according to whom non-sensory perceptions are not a mental *act*: they are a perceptual *datum* no less than sensory perceptions are, although of course, unlike them, they are governed, i.e. *formed*, by principles (such as proximity, similarity, etc.) also perceptually *given*, like those codified by Max Wertheimer.

In the ongoing lengthy critical discussions on this fundamental issue, no elements with functions similar to those of the intravisible factors have emerged, although they can be distinguished in the configuration shown in Fig. 2. Indeed, even if the four points a, b, c, d are not—in the analytical act—*seen* in the *figure* of a parallelogram, they are however necessarily *glimpsed* in their spatial relations consisting of their mutual *distances*. Actually, these too are visible, as a *background*, no less than the points marking their extremities.[26] They are perceivable in their *plurality* in that they are seen interrelated by their respective distances, which physically separate them but perceptually connect them.

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[25] See Benussi, *La natura delle cosiddette illusioni ottico-geometriche*. In S. De Sanctis (ed.), Atti del V Congresso Internazionale di Psicologia, Forzani, Roma 1903, pp. 262–267.

[26] The figure-ground relationship highlighted by Rubin as the primary condition of the perceptual act, as is well-known, represents the original foundation of the *Gestaltpsichologie*.

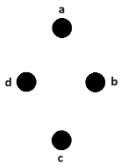

Fig. 2

This set of correlations *configures* a system of "perceptual relativity" which can resemble to a certain extent that found in physics. The fundamental correlation (from a physical as well as a perceptual point of view) is that relating to *space*, visualized by the background according to the methods shown by Rubin. These appear intrinsically paradoxical because this relationship is, as mentioned, of a relativistic nature, since none of the contracting parties is privileged compared to the others. Space is not the mere "screen" of the figures "drawn" on it, nor is it the simple container of three-dimensional objects (as conceived by Kant), it is the *intravisible condition* (therefore not the Kantian invisible *a priori* intuition), in this instance, of the spatial determination, brought about by the points, of the distances whose extremities are marked by those very points.

It is this determination that causes each of them to be perceived in its point-form and, at the same time, *also* in its position *indicated* by the vision of the distances in relation to the other points. Of course, an analytical act of perception, such as the one hypothesized by the theory of Brentanian origin, can cause the percipient subject to isolate each point from the others; but this is a mental act that can constitute an obstacle to *glimpsing* the reference system (the background) which is the condition, *also* visible, of its spatial determination, necessary for it to be seen and identified.

Ultimately, the vision of one point separates from that of the others, even if it is possible, is not consistent with the fact that each point has in common *with the others its* vision of their respective positions in space thanks to the *global* vision of their respective distances, which can appear in the form of a parallelogram.[27] Therefore, the points, *seen* as *isolated* from the spatial background through an analytical act, certainly represent an obstacle to the vision of the *global form*, shown by their unitary correlation in the various particular forms of their mutual distances. But their spatial determination, indispensable for the identification of each of them from the rest, makes them *at the same time intravisible indices* of the spatial connection lines which the distances between them are seen to trace in the form (otherwise

[27] In the global *form* the *whole is greater than the sum of its parts* because it is perceived in a non-summative way, therefore it is not sufficient to add the parts in order to obtain the whole.

visible indeed as *form*) of a parallelogram. This twofold dialectical capacity to permit the glimpsing of a possible "visivation" concealed within the immediate vision is precisely the typical and distinguishing feature of the "Intravisible Factor."[28]

The Gestaltist theory does not seem to consider necessary the exercise of a mediating function between the sensory (visible) and non-sensory (invisible), such as that performed by the intravisible, given the immediacy of the *formative action* of the perceptual forms, namely of the *Gestalten*, capable of self-regulating and “imposing themselves" on a perceptual level—according to the principles codified by Wertheimer and others—based on the sensory stimuli received. In essence the main difference, though not the only one, between the two theories seems therefore to be the substitution of the mental elaboration" postulated by Brentanian phenomenology with a system of direct psycho-physical self-regulation of the relationship between the peripheral perceptual system and the central (cortical) one.

In cases similar to the one previously examined, the unifying action of the principle of proximity (perhaps in conjunction with others) might, for example, be considered crucial to explaining the immediate perceptual synthesis of the sensory and non-sensory representations, which solves the problem of their real or seeming inconsistency.

Without fully addressing this arduous and still discussed problem (here only touched on purely by way of example), once again the opportunity presents itself to resort to the "acid test" of one of the most instructive perceptual paradoxes, Müller-Lyer’s well-known geometrical-optical illusion, the subject of numerous attempts at explanation, to which we do not propose to add another, save for a reconsideration of the terms of the paradox so as to translate them into the terms of a less challenging problem.

The so-called Müller-Lyer illusion shown in Fig. 3 is classified as a "length illusion" because the line between the external arrows seems longer than the line between the internal arrows.[29]

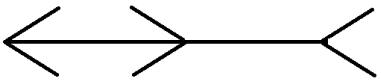

Fig. 3

[28] A point hides the space that it occupies but it also allows it to be glimpsed because it is seen in the space it is hiding. Two or more points outline an intravisible linear form in space, which can be visibilized sensibly by tracing it.

[29] One can easily observe the different lengths respectively generated on the horizontal line by the external and internal arrows.

This perceptual "visivation" is clearly of the kind defined by Benussi as gestaltic, and it is acceptable *in this respect* from a Gestaltist point of view. However, a "visivation" of the type termed by Benussi "analytical" is still possible, thus only by proving its inapplicability can the "gestaltic visivation" be considered truly explicative.

In fact, the two end points of the horizontal line—precisely because they are semi-concealed by the endpoints of the appendices—still remain *intravisible* even without a specific intentional analytical act—and the effect of the size of the figure also remains clear.

From a "phenomenoscopic" point of view, in this case too it is necessary to first highlight the *problem* in its essential terms, letting us glimpse the *phenomenal meaning*. As long as the horizontal segment remains isolated, what is primarily observed is the *length* between the two endpoints. However, affixing the appendices to the endpoints conjures up the meaning of *distance* linked to that of *proximity*, which coincides with one of the *principles* of the Gestalt regulation detected by Wertheimer. Indeed, the *internal* appendices make the endpoints of the base segment appear closer, while the *external* appendices make the endpoints appear farther apart. Consequently, the decrease and increase in its length depend on the decrease or increase in the distance between the said endpoints.

In fact, the greater or lesser length of the segment is generated by the *visible factor* of length, and this, in turn, by the *intravisible factor* of the distance-proximity between the appendices. The latter therefore remains the primary factor, as it is in the initial perception when the length is measured by the distance between its endpoints. These become semi-concealed and therefore intravisible when the appendices are affixed precisely because they coincide with the corresponding initial points of the appendices themselves. This, too, is the typical phenomenon of the *intravisible relationship*: the endpoints of the appendices and of the segment, though superimposed, allow one to *glimpse* their common reference to both segments, by virtue of which the *distance* between the appendices is *glimpsed* in the corresponding variations in *length* of the horizontal segment. This can be *made visible* by comparing the two configurations whose appendices are diagonal with the configuration whose appendices are vertical (see Fig. 4):

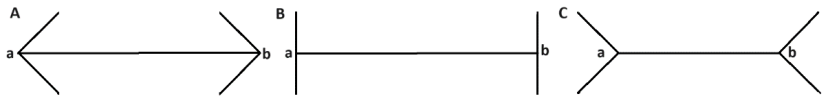

Fig. 4

In A and in C the points a and b, since they also belong to the respective appendices, refer, *as these* do, to the near appendices as well as those at the opposite end of the horizontal segment, and thus permit us to *glimpse* the distance acquired with this reference (*distance between the appendices*) in the corresponding variation—which is *seen*—in the length of that very segment. This is visibilized in Fig. 4 B by the absence of this variation due to the fact that the distance between the two vertical appendices is equal to that between the endpoints of the segment, hence their simultaneous belonging to the appendices themselves does not produce any change in the length of the segment.

Ultimately, therefore, the root cause of the illusion does not lie in *length* or in *distance-proximity*; they too are causes but insofar as they are the effect *of the ambivalence* of the endpoints of the segment—ambivalence which is not directly visible, as it is semi-concealed by their ambiguous belonging to both the segment and the appendices, but nevertheless *glimpseable* and therefore such as to be *made* visible by its *appearing* in the variable lengths of the segment.

These therefore prove to be the "visivation" of a *perceptual problem* generated *by the ambiguity* inherent in an *ambivalent* configuration. Fundamentally, this is a typical de-monstration that perceptual “logic” is guided by the need to make visible the *terms* of the problems regarding the perceived phenomena with a “visivation” that gives a reason for them.

THE COMPLEX SIMPLICITY OF THE INTRAVISIBLE

The term "intravisible" refers in the first place to the simple and common perceptual act of seeing in transparency, but with the intention of making visible, as completely as possible, the object or phenomenon glimpsed in a sensible datum immediately perceived (e.g. that of a cube) or in an explanatory diagram (as in mental experiments) or even in a mathematical formula (such as the *rvm* in the Lorentz transformation), and in other similar cases qualified to produce the *visivation* of the root cause, as such *semi-concealed*, of what appears on the surface, so as to provide a sharp *vision* of it and a potentially explanatory one of the elements and factors not clearly perceived in the immediate vision: this appears precisely as the *visibilization* of these elements and factors, which are, however, at the same time concealed or semi-concealed by it; thus they remain *intravisible* and can be made *visible* by another targeted visibilization, i.e. a *visivation* produced by means of mental experiments or other exploratory methods.

The primary incentive to activate procedures of visivation consists in the *observation* of problematic aspects of its immediate appearing perceived as intravisible *indicators* of the generative and explicative factors of a *vision*

free of negative conditioning and therefore suitable for detecting the *meanings* inherent in the specific logic of the perceived phenomenon or object, without separating it, but on the contrary, linking it to the logic of *signs* (mathematical, linguistic, artistic, etc.) that refer to it. This correlation is as necessary to the complete knowledge of the perceived as it is, in itself, problematic, because it is established between two poles—that of the *sensible* experience and that of the *conceptual Logos*—that can appear, and has appeared (as the history of ideas attests) heterogeneous, so much so that the second has sometimes been unduly established as judge of the first—which only in more recent times has been recognized as having its own autonomous, different logic.

The *intravisible* on the other hand, precisely because of its problematic appearing, incites both poles to seek convergent solutions suitable to integrate mutually; it poses as a mediator between them as it is homogeneous to both. A particularly significant attestation of this function is that provided by the *rvm*, which has proved to be a decisive explanatory factor in the phenomenoscopic analyses of Zeno's and Einstein's mental experiments, in which it appeared both in perceptual form and in the form of mathematical symbols and logical intuitions and deductions.

The demonstrated possibility of a constructive convergence of the two poles can open a wide range of fruitful mediations between oppositions as inveterate as they are sterile, such as those (to name but a few), between scientific thought and knowledge and the philosophical kind, between being and becoming, reality and its phenomenal appearing, meaning and reference, absolute and relative, unconditioned and conditioned, external world and conceptual world, mind and body, natural intelligence and artificial intelligence, etc.

The historical references of these and other similar oppositions are as well-known as they are relevant and persistent, also because they are well defended although not always defensible.[30] Critical analysis—precious legacy of the classical Logos—has often ended up becoming entrenched in harsh though not always lasting ideological barriers and in a formal rigor which is incompatible with an innovative and transparent openness to a non-*polemical* dia-*logos*.

Naturally the *Intravisible*, itself barely glimpsed, is not the key to open all doors and heal all oppositions... but it can perhaps help us to glimpse, beyond them, some less limited horizons.

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[30] I shall only briefly mention Kant's vast and influential theorization, also in commemoration of his 200th birthday—by now he really does show his age...

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