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DISCUSSING NATURAL MOTION: DEFINITION OF TIME AND VERBAL USAGE IN ARISTOTLE

Abstract

Aristotle posits that time, as defined by the "number of motion in respect of before and after" (*Physics* IV 11.219b1-2), is an inherent property of motion itself rather than a prerequisite. This implies the possibility of identifying time-independent properties of natural motions. One such critical feature, crucial to understanding the basic meaning of time, is the presence of an inherent order of before and after within motion, regardless of time. The concept of a non-temporal before and after within motion is now accepted or seriously considered in scholarly discussions. However, it remains one of the most confusing and difficult issues in the interpretation of Aristotle's conception of time. How can we conceive of motion apart from time? Moreover, how does Aristotle seemingly take this aspect for granted? In order to address these issues, I propose to combine philosophical inquiry with grammatical and mathematical reflections. I will examine the analysis of motion alongside the verbs used to describe it, with a keen focus on aspect. Hence I will draw connections between the relationship of motion and time and that of physical and mathematical objects.

Keywords

Aristotle, *Physics*, Time, Motion, Number

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Introduction

In a groundbreaking article exploring the intricate relationship between philosophical discourse and grammatical analysis, Philippe Hoffmann delves into the correlation between verb description in grammar and the philosophical understanding of time.[1] Hoffmann's study revolves around the observation that the grammatical differentiation between verb aspect and tense can be partially traced back to the Stoic philosophers' examination of time.[2] Consequently, grammatical analysis exerted an influence on Neoplatonic philosophy. In particular this shaped the concept of time, that was defined by Damascius as the "measure of being's extension (παράτασις)".[3]

Considering Hoffmann's standpoint, my intention is to put forth the reconstruction of a "zero" stage, showcasing how verbal aspect influenced the philosophical examination of time before the advent of the Stoics, even before being formalized through grammatical reflection. I especially concentrate on Aristotle's conception of time and of its aspectual attributes as outlined in the *Physics* – a work that, it should be noted, Damascius identifies as a primary source.

My intention is not to claim that Aristotle's exploration of time entails a formalization of the rules of the Greek verb; nor that it stems from a deliberate analysis of these rules. Rather, my observation relates to the fact that Aristotle engages in thought and writing within a language that displays sensitivity towards what would later be designated as the aspect of the verb, and that it is valuable to consider this aspect.[4]

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[1] Hoffmann (1983).

[2] *Ibid*., pp. 2-6. It is worth noting that in this case, the term παράτασις itself, which lies at the heart of the definition, is borrowed from grammar, where it refers to the durative aspect of the verb.

[3] Μέτρον τῆς τοῦ εἶναι παρατάσεως.

[4] This work is heavily influenced by the discussions the author engaged in with Alberto Merzari over the years, especially concerning the aspect of Greek verbs. The idea was first introduced to him in a somewhat muddled state during a time that now feels almost remote. It was only through Alberto's patient listening and reading, coupled with his remarkable ability to consistently ask the right questions – questions that challenged everything each time – that the idea finally took on a definite shape.

Dealing with research subjects, Aristotle pays special attention to the way they are expressed by ordinary language. As time is inherently connected to motion – it is, by definition, the "number of motion in respect of before and after" – and as language conveys motion through its verbal system, we have good reasons to suppose that the features of the verbal system might have influenced the outcome of the inquiry to some degree. In the subsequent discussion, I will adopt this assumption as a working hypothesis and explore its implications.[5]

My intention is to show how recognizing the significance of the aspectual component can help address some of the interpretive challenges associated with Aristotle's conception of time. I especially refer to the fact that, according to Aristotle, time is a quality inherent in natural motion and not a prerequisite for it: ontologically, motion "precedes" time.

This implies that some attributes of motion, and some verbal aspects which are used to depict motion, do not depend on time. One of these attributes, one which is crucial to understand the very definition of time, is the inherent order of before and after within natural motion: this order is irrespective of time, as Aristotle says.[6]

The need to establish a non-temporal, or pre-temporal, concept of before and after within motion is currently acknowledged and extensively explored in scholarly works.[7] However, it still stands as one of the most

[5] The relationship between language structure and Aristotle's thinking has been and continues to be a subject of extensive debate. Given the ongoing nature of the discussion and the diversity of viewpoints, there are various working hypotheses that can be considered. The conclusions reached in this article are heavily influenced by the premise I have chosen to embrace and the specific position I adopt within the previously mentioned debate. For further insights on this matter, I recommend exploring the writings of Benveniste (1966), as well as the works of Wieland (1985) and Graham (1980), which provide valuable perspectives.

[6] I focus on natural motions, or rather, natural changes, as these alone constitute the subject matter of Aristotle's physics. It is through them that we can truly grasp the essence of temporal structure, although this framework can also be extended to encompass other types of motion (as well as states and objects, see Section 3.3). Just as Aristotle uses the example of a sculptor shaping a statue to shed light on certain aspects of the theory of the four causes, even though it is not a natural example, he occasionally employs non-natural movements, like traveling from Athens to Thebes, to clarify certain aspects of the relationship between time and motion. It is important to recognize the strictly analogical role they play.

[7] For a more focused analysis, I recommend exploring White (1992), where the concept of "before and after" is described as a "directed linear dimension." More recent contributions,

enigmatic and perplexing aspects of Aristotle's understanding of time. How can we conceive of motion separately from time? Moreover, how could Aristotle seemingly treat this notion as almost self-evident?

To tackle these inquiries, my proposition is to merge philosophical investigation with grammatical reflections. We can shed light on these questions by juxtaposing the analysis of motion with the linguistic elements used to convey it. Indeed, the primacy of motion over time is more readily embraced when situated within the framework of ancient Greek, a language in which the verb, as the vehicle for expressing motion, exhibits a heightened sensitivity to what we now refer to as the aspect.[8] However, the distinction between the concept of time and the order of motion may pose greater

such as Coope (2005) on "before and after," Roark (2011) on "kinetic order," and Sentesy (2018) on "precedence structure," shed light on the topic. Referring specifically to Sentesy (2018), who revisits and comments on the earlier authors (except for White 1992, whose positions are, nonetheless, quite similar to those presented by Sentesy), it is important to note that I will deviate from the interpretation offered on two key points. Firstly, I disagree with the notion that Aristotle's definition refers solely to duration, specifically as a unit of measurement for the duration of motion. Sentesy (2018, p. 283) argues that "a unit of time is an extent that we abstract from a particular motion by marking off that motion," aligning with White (1992, p. 78), who suggests that "a time is an interval of motion that is limited or bounded in the prior and posterior 'direction' and is considered as a quantitative unit by which motion can be measured." In both cases, the "now" (νῦν) delineates and determines time in this sense. Counting the "nows" effectively involves measuring the units. While White acknowledges that Aristotle recognizes both metric and topological senses of time (a "continuous manifold of time"), Sentesy argues that the metric sense is the only one Aristotle employs. Essentially, according to Sentesy (pp. 282-3, 294-305), an object's extension coincides with (and is exhausted by) its measure. In the following discussion, I will endeavor to show that just as extension encompasses more than a specific quantity (e.g., a measured length of 7 meters), time also extends beyond a precise quantity (e.g., a measured duration of motion). Like extension, time is distinct from the measure of motion (although inseparable from it). To illustrate this, I will contrast the traditional interpretation of mathematics as abstraction with an interpretation based on "subtraction."

[8] I do not intend to dive into the extensively debated question of how aspect is formally expressed in Greek grammar and its possible dating. Instead, I would like to focus on the fact that the Greek verbal system exhibits certain characteristics, known as aspectual features in modern linguistic analysis, which are distinct from tense. For a deeper understanding of the relationship between aspect and tense in the Greek verbal system, I recommend consulting works such as Duhoux (1995, 2000), Rijksbaron (1989, 2011), and Boas et al. (2019). The issue of formalizing aspectual features is discussed in Lallot (1985) and Eco Conti (2009). Additionally, the presence or absence of aspectual categories among the Stoics is a topic explored in Manetti (2022).

challenges in our modern languages, where verbs predominantly signify time and have become less attuned to aspect in many cases.

Building upon this perspective, I will introduce a second assumption, concerning Aristotle's stance on mathematics and the interplay between mathematics and physics.[9] Specifically, I am referring to the fact that Aristotle believed mathematical objects do not exist separately from physical objects, but rather are derived from them through subtraction. For example, three-dimensional extension is always associated with a physical body and does not exist independently as what we would call space. It is not unreasonable to assume that just as Aristotle did not require a self-subsistent space to accommodate objects, he also did not need a self-subsistent time to accommodate movements.

In Section 1, I will investigate the concept of natural motion itself, exploring it as an undivided and purpose-driven whole. I will also discuss its connection to the structure of the present, along with the related ideas of *paratasis* and extended present.

Moving on to Section 2, I will follow Aristotle's logical path and demonstrate how we can uncover an internal structure within natural motion that is logically ordered but distinct from both motion and time. This structure, referred to by Aristotle as "the before and after in motion," will be referred to as the "successiveness" of motion.[10] I will also link it to the grammatical notion of the perfect tense and to the concept of the "now" as the boundary between what came before and what comes after, without any extension. Additionally, I will examine the relationship between motion and "successiveness" in the context of physical and mathematical objects.

Section 3 will focus on the interplay of the successiveness of different motions, leading to the commonly understood notions of time, number and "now" as the boundary between past and future. I will also explore the use of

[9] The nature of mathematical objects is also subject to extensive debate, and various interpretations are possible, particularly due to the limited passages in which Aristotle directly addresses the topic. The interpretation I adopt in this work is discussed in Ugaglia (2017). The issue of mathematics in Aristotle is addressed in Mueller (1970), Lear (1982), Cleary (1995), and Mendell (2008).

[10] The term "successiveness" suggests the relationship that this structure shares with the notion of transition to the next in mathematical logic.

the perfect tense to denote temporal significance and contrast the unextended punctual "now" with the extended present. Furthermore, I will connect the unextended "now" to the definition of time as a number and the extended present to the notion of measurement.

Section 4 concludes discussing the unresolved question of the objectivity of time.

1. Movement without Time

The notion of movement underlying classical physics is fundamentally different from Aristotle's conception of movement,[11] and it ultimately boils down to a trajectory in space,[12] which presupposes not only the notion of space but also that of time.

In contrast, a natural movement as understood by Aristotle cannot be reduced to a trajectory alone. It encompasses more than just a trajectory; it has an essence beyond that. This is a crucial point for understanding the relationship between movement and time. For Aristotle, time is not a precondition but a property of movement, something that, as we shall see, relates to the "mathematical skeleton" of a natural movement.

It is immediately evident from the definitions themselves that, for Aristotle, time comes after movement in both logical and ontological senses. The definition of time includes the notion of movement – time is the *number of movement in respect of before and after*[13] – while the definition of movement – movement is the *actuality of what is potentially as such*[14] – does not in any way refer to time.[15]

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[11] I translate the term "κίνησις" as "movement," which Aristotle uses in Books III and IV of the *Physics* to denote change in its broadest sense. Elsewhere, he uses the term "μεταβολή," reserving "κίνησις" for change that does not involve substance. As mentioned in n. 6 above, I am referring to natural changes specifically.

[12] More accurately, we can say that motion can be described as a trajectory within a phase space.

[13] τοῦτο γάρ ἐστιν ὁ χρόνος, ἀριθμὸς κινήσεως κατὰ τὸ πρότερον καὶ ὕστερον (*Phys.* IV 11.219b1-2).

[14] ἡ τοῦ δυνάμει ὄντος εντελέχεια, ἥ τοιοῦτον, κίνησίς ἐστιν (*Phys.* III 1.201a10-11). The definition is then reformulated in terms of the movable and the mover: "the actuality of the movable qua movable" (ἐντελέχεια τοῦ κινητοῦ, ἡ κινητόν) or "the actuality of the movable by the mover" (ἐντελέχεια γάρ ἐστι τούτου ὑπὸ τοῦ κινητικοῦ).

[15] For further discussion on this matter, see Roark (2011) pp. 80-1.

Based on this latter definition, in the following two Sections, I will highlight certain aspects of Aristotle's treatment of movement that are essential for the subsequent investigation of time.

1.1 Movement as a Relation between Mover and Movable

Aristotle defines movement in terms of actuality (ἐντελέχεια): movement is the actuality of the movable insofar as a movable, meaning insofar as it is moved by a mover.[16] The mover possesses the actual form that the movable has only potentially. Thus, there is a hierarchy or, if you will, an ordering relationship between the mover and the movable, where the movable, or the privation of form, precedes the mover, or the possession of that form or purpose. However, as long as a natural movement is understood as a state of relation between the movable and its mover, this order does not manifest itself. Movement is a whole, undivided and indivisible, in which the privation and possession of form coexist.

This actuality, referring to the condition of relation between a movable object and its mover, is perceived by us as a process. In this perspective, the mover remains in the background, and movement appears to us as "something" encompassed between an initial state and a final state of the movable object.[17] Let us call the initial state A, which corresponds to the movable in a state of privation of form, and let us call the final state, now the purpose of the movement, Ω, which corresponds to the moved object in a state of possessing the form.

The same hierarchy that connects the movable object (privation of form) and the mover (possession of form) in a relational perspective also connects the initial state of the movable object and the final state in a processual perspective. We can therefore say that, from a purely ontological

[16] ἐντελέχεια τοῦ κινητοῦ, ἢ κινητόν (*Phys.* III 1.202a7-8) ἐντελέχεια γάρ ἐστι τούτου ὑπὸ τοῦ κινητικοῦ (*Phys.* III 1.202a14).

[17] Although the mover may not be explicitly mentioned, it remains an indispensable element in Aristotle's understanding of motion. Even when examined from the perspective of the movable object, motion is shaped by its connection to a mover that brings forth the actualization of form and the purpose behind the motion. The significance of the mover's presence is explored in Aristotle's *Physics* III (where motion is defined), IV, and VIII. The issues arising from the omission of the movable-mover relationship in the definition of motion are discussed in Ugaglia (2016).

point of view, even the beginning and end of a natural movement are in a specific ordering relationship: A comes before, Ω comes after, and the movement, let us call it m, is what lies in between. However, this order is internal to the action, an order we can call teleological, and it reflects, at the level of individual movement, the teleologically oriented structure of Aristotle's cosmos. This order is not (yet) related to time.

According to Aristotle, the before and after are primarily in place, then in movement, and finally in time.[18] This clarification is crucial: without an external orienting structure to refer to – specifically when interpreting movements not within Aristotle's cosmos but within the space of our physics – it would be impossible to understand the before/after of movement independent of that of time. This would render the definition of time inevitably circular.[19] The same holds true when considering any type of movement, not just natural ones. In such cases, the concept of before/after becomes solely a matter of relative position – that is, of geometry – rather than an absolute one as seen in the context of natural movement.

Let us not forget that for Aristotle, place is not a geometric entity but a physical object. It is the surface of separation between two physical bodies that are part of the cosmos. However, the cosmos is oriented, and consequently, so are the places: the low, or center, is the place of heavy bodies, while the high, or periphery, is the place of light bodies.[20] This allows for the establishment of an absolute ordering relationship and enables us to

[18] τὸ δὴ πρότερον καὶ ὕστερον ἐν τόπῳ πρῶτόν ἐστιν. ἐνταῦθα μὲν δὴ τῇ θέσει· ἐπεὶ δ' ἐν τῷ μεγέθει ἔστι τὸ πρότερον καὶ ὕστερον, ἀνάγκη καὶ ἐν κινήσει εἶναι τὸ πρότερον καὶ ὕστερον, ἀνάλογον τοῖς ἐκεῖ. ἀλλὰ μὴν καὶ ἐν χρόνῳ ἔστιν τὸ πρότερον καὶ ὕστερον διὰ τὸ ἀκολουθεῖν ἀεὶ θατέρῳ θάτερον αὐτῶν (*Phys.* IV 11.219a14-19). The order of the cosmos plays a direct role in determining the before/after of local motion, but it also indirectly influences the before/after of other types of motion. Here, the order is not established between the beginning and the end as locations within the cosmos, but rather between the movable object and the mover as physical entities belonging to the cosmos, and thus linked by an ontological ordering relationship.

[19] The definition of motion exhibits a similar circularity when attempting to interpret potentiality solely in terms of the potentiality of the movable, disregarding the role of the mover.

[20] According to Aristotle, a place is not a portion of space, nor is it merely a surface located within space. It is always the boundary of a body, much like how an extension is always the extension of a body. For more insights on this topic, see Section 2.1 below.

interpret movements naturally occurring in the cosmos as movements which are always oriented, regardless of temporal considerations.[21] There is a hierarchy among the physical substances that constitute the cosmos, and that means there is a hierarchy among the mover/movable pairs that define a movement in a relational sense. Consequently, there is a hierarchy among the places in the cosmos, and that means there is a hierarchy among the purpose/initial pairs that characterize a natural movement in a processual sense.

1.2 Movement and the Structure of the Present

It is interesting to note how this type of internal, non-chronological order within movement is naturally expressed in the Greek verbal system through what grammarians would call aspect. In the words of Yves Duhoux:

> Il importe de ne pas confondre les notions de début – milieu – fin du procès, qui ressortissent à l'aspect, avec celles de procès passé – actuel – à venir, qui sont du domaine de la temporalité. La temporalité établit une relation chronologique entre le procès et un point de repère *extérieur* à ce dernier: l'action est présentée comme antérieure – contemporaine – postérieure à ce point de repère. L'aspect, par contre, établit un rapport entre le procès et les trois phases principales *de son propre développement* (début – milieu – fin). Il ne suppose intrinsèquement aucune temporalité extérieure au procès et est donc indépendant de la localisation chronologique de l'action.[22]

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[21] On the other hand, Roark (2011) pp. 80-101, proposes to arrange places based on movements. To do so, he introduces the distinction between telic properties and plastic properties (pp. 67-71) and describes the inherent directionality of movement as kinetic order (p. 93). Similarly, Sentesy (2018) pp. 289-94, while initially appearing to accept that the before/after primarily resides in the cosmos, later seeks to demonstrate that magnitude is oriented by leveraging the orientation of movement itself ("What establishes the orientedness of a magnitude? [...] here, I aim to show, orientations derive from movement"). Movement derives its order from the movable, so that the before/after aligns with the potentiality of the movable (p. 292). This interpretation is acceptable, in my view, only if we replace the potentiality of the movable with the relationship between (the potentiality of) the movable and (the actuality) of the mover (see nn. 17-19 above for further details).

[22] Duhoux (2000) §123 (Author's original italics). Building on Duhoux's work, I use the term "aspect" to describe the morphological representation of the unfolding of a process: "Toute action peut être envisagée du point de vue de son *développement*, c'est à dire de la succession de phases diverses par lesquelles on peut se représenter son déroulement. Il est possible de considérer ce développement de multiples façons. On songera d'abord à trois étapes très évidentes de son évolution: début-milieu-fin. Cette tripartition s'applique de manière claire dans les verbes transformatifs" (§122).

In particular, the unfolding action is expressed by the verb in the present tense (or imperfect tense: imperfective aspect).[23] The present tense highlights the fact that the subject is in a certain state: if we consider the movement from a relational perspective, it is in relation to a mover; if we consider it from a processual perspective, it's situated between an initial and a final state. What matters is that we are describing the movement as observed "from within," solely in terms of being prior to the purpose and in relation to it: I am growing (I am in the process of growing), the fruit was ripening (it was in the process of ripening), the pupil is learning (he is in the process of learning) and so on.

Although the beginning and the end have an order, just like the movable and the mover, what comes in between does not have that order, or at least not at this level of discourse. When expressed with an imperfective verb, the movement is considered as a whole: even if there is an internal order within the action, it is not explicitly stated. I will employ the locution "structure of the present" to refer to this level of discourse – that is, movement understood as a relationship and described as an indivisible whole, encompassing a beginning and an end and expressed in the present tense (or imperfect tense). It is clear that in this case, the present, in which I say "I am walking now," does not refer to a specific instant (νῦν) but to an interval of movement,[24] what the Stoics called the "extended present" (ἐνεστὼς παρατατικός).[25]

This is the everyday present, but what does it mean to assert that something is happening "now"? What is the relationship between the present and the now (νῦν)?

1.2.1 Present and Now

When we talk about movement from an internal perspective, referring to an action in its unfolding, we employ a present tense verb to indicate the

[23] If not specified otherwise, I use the terminology proposed by Boas et al. (2019). For a more detailed discussion on the perfective aspect, see pp. 405-6.

[24] In *Phys.* VI 3 Aristotle shows that if the "now" is taken in its proper sense of a punctual limit, a phrase like "I am walking now" has no meaning. For saying that something is walking, or its moving in general, we need two nows. See n. 65 below.

[25] The term παρατατικός can also be translated as "continuative" or "imperfect," and according to the Stoics, it denotes a contrast with the συντελεστικός (perfect, complete) aspect. For a discussion on the extended present and the extended past (παρῳχημένος παρατατικός) within this perspective, see Hoffmann (1983).

relational state between the object in motion and its mover, capturing the movable object's condition of "being somewhere" before its purpose, regardless of the specific location. The term "now," used in this context, signifies this "extended" condition.

However, the situation changes when we shift our attention from the internal perspective of movement to the external observation of it. Let us imagine ourselves at the end of the action, at the extreme Ω, and observe the movement. In this scenario, it is natural to employ a verb in the perfect (or pluperfect) tense, utilizing aspect to emphasize not the ongoing action, but rather the outcome or effect that has been achieved through its completion. The present tense and perfect tense are not distinguished according to chronological differences, but rather by their focus on different aspects of the same action: the present tense emphasizes the ongoing process, while the perfect tense denotes the fulfillment of the intended purpose. If we use the perfect tense in this context, the term "now" refers to a punctual state that aligns with the culmination of the movement at the extreme Ω. The perfect tense needs a reference point from which we can observe and perceive the action as fully accomplished.

Hence, using the perfect tense to describe an internal point within a natural movement would be illogical. Employing the perfect tense would imply declaring the attainment of a specific purpose, effectively interrupting the ongoing action. However, interrupting a movement poses no issues in our context, where it can ultimately be reduced to a trajectory and is divisible at any point. We not only find it effortless to conceptualize movement as a composition of individual segments, but it is also challenging for us to imagine someone thinking otherwise.

Nevertheless, dividing the physical object's "natural movement" into distinct parts can be misleading within Aristotle's physics. According to Aristotle, a natural movement cannot be reduced solely to a trajectory; it encompasses more than that. Movement, in essence, is always directed towards a purpose, and its significance lies in being governed in its entirety by that purpose. In Newtonian physics, the direction of movement is relative, allowing for reversibility, and each segment of movement carries meaning on its own, independent of the whole. For instance, consider a falling stone or the

same stone thrown upward with the same speed that it hit the ground. In this context, we can easily divide the motion into distinct parts. Thus, representing movement as a segment feels intuitive to us.

However, this perspective no longer holds true when we consider a natural movement as conceived by Aristotle. Let us imagine representing a movement from an initial state A to its purpose Ω using a segment AΩ:

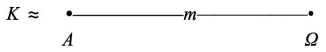

Figure 1

Since the segment can be divided anywhere, let us imagine dividing it at a point, call it B, between A and Ω. Point B divides the AΩ segment into two parts: AB and BΩ, the former representing the "before" and the latter the "after". The sum of these two parts gives us the original segment. But what about the movement itself? In this case, point B, being the endpoint of movement AB, also serves as its purpose. However, according to Aristotle, the purpose, which completely determines a movement, bestows a distinct ontological autonomy upon movement AB, setting it apart from movement AΩ, even though they share the same starting point.[26] For Aristotle, a movement is not composed of discrete "pieces" of movement,[27] and the concept of a "state," understood as an internal point within a movement or a division that separates the movement into pieces, lacks meaning. Therefore, the only states that truly matter are the initial and final extremes, A and Ω.

Furthermore, it is worth noting that Ω, despite being the ultimate goal of the movement – or perhaps precisely because it is the ultimate goal – does not belong to the movement itself, according to Aristotle. Instead, it belongs to the state to which the movement has brought the object, the state we previously referred to using the perfect tense.

[26] Aristotle addresses the problem in *Phys.* VIII 8, specifically at 262a12-b8.

[27] As mentioned earlier, such considerations become meaningless in a context like contemporary physics, where motion has shed its qualitative aspects that were fundamental in Aristotle's framework, and it has become a purely quantitative concept focused on distance covered, time elapsed, velocity, and variations in these variables.

A similar line of reasoning can be applied to the beginning; so, if we wish to continue representing the movement as a segment, we must emphasize that the segment is open-ended:[28]

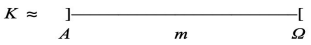

Figure 2

Looking at movement "from within" as an open-ended interval fits well with the earlier observation that the Greek language only speaks of it in the present (or imperfect) tense. In this case, the imperfect aspect not only refers to the ongoing nature of the action but also highlights its boundlessness.[29]

However, once we turn our attention to the limit, specifically when we adopt the perspective of Ω, movement is described using the perfect (or pluperfect) tense. This use of the perfect tense emphasizes that once the purpose has been achieved, the condition that justified the movement ceases to exist, and consequently, so too does the movement itself. It is important to note that Ω does not belong to the movement but rather to the state that the movement has brought us to, or as Aristotelian philosophy suggests, to the movable object's state of having already undergone motion. As we delve further, we will find it useful to represent this state as a closed interval.

Aristotle's keen attention to the use of verbal forms, and specifically the primacy of aspectual characteristics over temporal ones, is aptly demonstrated in the following passage from Book VI of the *Physics*:

εἰ δὴ ἀνάγκη: τὸ κινούμενον ποθέν ποι μὴ ἅμα κινεῖσθαι καὶ κεκινῆσθαι οὗ ἐκινεῖτο ὅτε ἐκινεῖτο, οἷον εἰ Θήβαζέ τι βαδίζει, ἀδύνατον ἅμα βαδίζειν Θήβαζε καὶ βεβαδικέναι Θήβαζε, τὴν δὲ τὸ Α τὴν ἀμερῆ ἐκινεῖτο τὸ Ω, ἢ ἡ τὸ Δ κίνησις παρῆν (c) ὥστ' εἰ μὲν ὕστερον διήλθεν* (*διήλθεν codd.: διεληλύθει Ross 1936) ἢ διῆει διαιρετὴ ἂν εἴη (ὅτε γὰρ διῆει, οὔτε ἠρέμει οὔτε διεληλύθει, ἀλλὰ μεταξὺ ἦν). εἰ δ' ἅμα διέρχεται καὶ διελήλυθε, τὸ βαδίζον, ὅτε βαδίζει, βεβαδικὸς ἐκεῖ ἔσται καὶ κεκινημένον οὗ κινεῖται (*Phys.* VI 1.231b28-232a6).
Now a thing that is in motion from one place to another cannot at the moment when it was in motion both be in motion and at the same time have completed its motion at the place

[28] An interval is called open if it does not include its endpoints, and closed if it does. See Rijksbaron (1989) pp. 42-50, where analogous considerations are brought forward using the notion of "completeness".
[29] The imperfective aspect is also referred to as unbounded (Boss et al. 2019, p. 406).

to which it was in motion (e.g. if a man is walking to Thebes, he cannot be walking to Thebes and at the same time have completed his walk to Thebes); and, as we saw, Z traverses the partless section A in virtue of the presence of the motion D. Consequently, if Z actually passed through A after being in process of passing through, the motion must be divisible; for at the time when Z was passing through, it neither was at rest nor had completed its passage but was in an intermediate state; while if it is passing through and has completed its passage at the same time, then that which is walking will at the moment when it is walking have completed its walk and will be in the place to which it is walking; that is to say, it will have completed its motion at the place to which it is in motion (Edition with a minor change to Ross 1936; Translation, here and elsewhere, with minor changes to Barnes 1984).

Given that the verbal system effectively conveys the concept of movement, and does so quite effectively, the presence of two distinct forms – one indicating completion [perfect] and the other denoting ongoing action [present] – necessarily reflects an inherent distinction within the movement itself, which the verb merely articulates. This distinction essentially suggests that movement encompasses both a mean and two ends (with a focus on the end Ω). By employing the perfect tense, we discuss the movement from the perspective of the end, Ω, whereas the present tense provides a viewpoint from the mean, represented as *m*.

1.3 Movement without Purpose

The statements made in the previous Section apply to what are commonly known as telic (goal-oriented) or transformative verbs, such as "go," "build," "learn." These verbs refer to actions that represent what philosophy calls proper movements, characterized by a transition from an initial state A to a qualitatively different final state Ω. In state A, the object lacks a certain form that it attains in state Ω.

However, there are cases where a verb denotes a different kind of situation, where it is impossible to differentiate qualitatively between states A and Ω. Consider verbs like "see," "hear," "experience pleasure" and so on. These situations do not involve a progression towards a particular form; rather, they indicate a state of possessing that form. To describe such situations, Aristotle occasionally uses the term *energeia*, while modern grammar refers to them as stative or atelic verbs.[30]

[30] Although the passage from *Metaphysics* on which Graham's analysis is based (*Metaph.* Θ 6.1048b18-36) has been reasonably questioned in terms of its placement and authenticity in

I will also adopt the term *energeia* and contrast it with *kinesis*. However, since the word has different meanings in Aristotelian texts, I want to clarify that here it will be used solely as an abbreviation of the phrase: "a situation that, like *kinesis*, is described by a verbal form but differs from proper movement because, unlike the latter, it contains its purpose." Let us consider the difference between doing something and seeing it. Doing is a *kinesis*, while seeing is an *energeia*. While one can both see and have seen, one cannot simultaneously do and have done:[31]

"ἆρ' ἐνδέχεται τὸ αὐτὸ ἅμα ποιεῖν τε καὶ πεποιηκέναι;" "οὔ." "ἀλλὰ μὴν ὁρᾶν γέ τι ἅμα καὶ ἑωρακέναι τὸ αὐτὸ καὶ κατὰ ταὐτὸ ἐνδέχεται." (*Soph. el.* 22.178a9-11)
"Is it possible to be doing and to have done the same thing at the same time?" "No". "But it is surely possible to be seeing and to have seen the same thing at the same time and in the same respect."

What holds true for seeing applies more generally to perceiving:

ἅπαν ἅμα ἀκούει καὶ ἀκήκοε, καὶ ὅλως αἰσθάνεται καὶ ἤσθηται, καὶ μὴ ἐστι γένεσις αὐτῶν ... (*De sens.* 6.446b2-4).
Now, even if one always hears and has heard – and, in general, perceives and has perceived – at the same time, and these acts do not come into being but occur without coming into being...

In the case of *energeia*, the distinction between the mean (m) and the extremes (A and Ω) that exists in *kinesis* does not apply. While in *kinesis*, I must use the present tense when speaking from within (I am building, I am learning, etc.), and only from the perspective of the final extreme can I use the perfect tense (I have built, I have learned, etc.), when describing an *energeia*, I can use either the present or the perfect tense interchangeably. I can say that I am seeing and that I have seen, or rather, that I am in the state of

Burnyeat (2008), I do not find the critique of Graham's conclusions convincing at all. These conclusions are not necessarily tied to the dubious passage and can be generally applied to Aristotle's distinction between proper movements, characterized by an external purpose, and "states" or acts or *energeiai*, characterized by an internal and ever-present purpose (see especially *Topics* VI 8.146b13-19; *Soph. el.* 22.178a9-11, *De sens.* 6.446b2-4). Rijksbaron (1989) follows a similar line of thought and has also been criticized (despite being widely utilized) in Burnyeat (2008).

[31] Regarding perception understood as a state that encompasses form and is thus always complete, and differs in this respect from *kinesis*, see *EN* X 4.1174b14-20.

having seen (perfect); that I am thinking and that I am in the state of having thought and so on.

This places all points of an *energeia* on an equal level and has two important consequences: first, I can no longer speak of absolute beginnings, ends, and mean; second, I can divide the action. In a movement, a point is either a beginning (when it coincides with A), an end (when it coincides with Ω), or it belongs to the mean (when it belongs to *m*). However, in an *energeia*, every point can be interpreted as both a beginning, an end, or belonging to the mean.

If we adopt the conventions from the previous Section and represent *kinesis* as a segment, where the order is A-m-Ω linearly manifested:

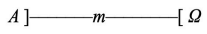

Figure 3

One effective way to represent the order in an *energeia* is in the shape of a circle:

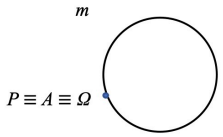

Figure 4

A point *P* on the circumference can be viewed as both a starting point, an endpoint, or a point belonging to *m*.[32] If we consider it as belonging to the interval m, where no divisions are made, we can describe it in the present tense. However, if we see it as an endpoint, we can express it in the perfect tense, referring to its role as the goal of *m* (it is worth noting that *m* lies between the point *P* when seen as the starting point $P \equiv A$ and the same point when seen as the endpoint $P \equiv \Omega$). But there is an additional aspect: this perfect tense can be understood either in a stative sense – "I am in the state of having seen" – or in a resultative sense – "I have accomplished the

[32] τὸ γὰρ ἐκ τοῦ Α κινούμενον ἅμα κινήσεται εἰς τὸ Α κατὰ τὴν αὐτὴν πρόθεσιν (*Phys.* VIII 8.264b10-11).

action of seeing"[33] – depending on what we observe from the perspective of the endpoint *P*.

If I consider *P* as both the endpoint and the starting point ($P \equiv \Omega \equiv A$), viewing *m* as what precedes *P* ($P \equiv \Omega$) and simultaneously as what follows *P* ($P \equiv A$), then I use the perfect tense in a stative sense. However, if I focus on *P* solely as the endpoint ($P \equiv \Omega$) and perceive *m* only as what comes before, then I employ it in a resultative sense.

This holds true for every single point: if I can claim that I have completed the act of seeing at each point, I can also envision fragmenting my *energeia* without destroying it because it is already fully realized everywhere. Unlike a *kinesis*, an *energeia* can be dissected and contemplated as composed of these fragments. Unlike a *kinesis*, it is meaningful to speak of an "internal state" within an *energeia*.[34]

2. Movement and Successiveness

But what sets apart a *kinesis* from an *energeia* at its core? What prevents us from breaking down a movement, in its true sense, if not its inherent teleological purpose, encompassing two physically distinct states? Let us try to

[33] At this stage, it is worth noting how Aristotle's analysis aligns with the period which Chantraine (1926) refers to as the perfect resultative, pertaining to the outcome of a process. In his influential work, Chantraine identifies three phases in the development of the perfect tense: (a) perfect with a purely aspectual value (being in a state), (b) perfect resultative, and (c) perfect temporal. In the first two phases, aspect takes precedence over time – if we were to place them in a temporal context, both would be situated in the present, although (b) refers to an event in the past. In phase (c), however, time becomes dominant, and the perfect tense effectively becomes a past tense. According to Chantraine, in both (a) and (b), the perfect tense refers to an extension that, in (b), is "absorbed" into the past, allowing the present state, achieved through the process, to be seen as unextended, or as the culmination of that process. I will not delve into the matter here of the relationship between resultativity and transitivity, which is related but not essential to our interpretation, and for which Chantraine's analysis has faced criticism (see, for example, Rijksbaron 1984 and Duhoux 2000, §§371-2). See Bentein (2012) §2 for an articulate discussion on the semantics of the perfect.

[34] Regarding the fact that it is the absence of an "external" purpose that makes the difference, see *Topics* VI 8.146b13-19 and *EN* X 5.1175a29-35: the pleasure of the geometer lies in the act of doing geometry, not in its completion, precisely because he is actively engaged in the process (see *EN* VII 12.1153a7-17; X 4.1173a17-21 e 1174b7-10).

imagine a natural movement devoid of these physical distinctions and see what, if anything, remains.

2.1 Objects and Movements

Because the purpose of this operation might seem unclear or not immediately obvious, I will try to clarify it using a similar operation that may be more familiar to readers of Aristotle. Let us consider what happens when we take a natural object, instead of a movement, and examine it apart from its physical qualities.

What occurs is that we transform the physical object into a mathematical object. In other words, we no longer perceive the object in its physical form, but rather from a mathematical perspective. This aligns with Aristotle's view that mathematical objects are simply physical objects seen through a different lens, devoid of any teleological considerations.[35]

For instance, we can analyze a material body like a bronze cube, setting aside its intended purpose. Through this process, we arrive at its geometrical structure and at the concept of a cube. Aristotle refers to this operation as "subtraction" (αφαίρεσις), whereby we strip away the physical qualities to isolate an underlying mathematical structure.[36]

Through the process of subtraction, we arrive at Aristotle's equivalent of what we commonly refer to as space.[37] I use this terminology because Aristotle does not recognize the existence of a separate and independent space,

[35] See *Metaph.* M 3.1077b22-1078a9; N 2.1090a13-15; *Phys.* II 2.193b23-194a12; *De An.* I 1.403a15-16.

[36] *Metaph.* E 1.1026a14-15. The term used by Aristotle for this operation, αφαίρεσις, in Greek mathematics specifically denotes subtraction. This is one of the reasons why I do not translate αφαίρεσις as "abstraction," as is customary. According to Aristotle, it is not the mathematical object that is "abstracted" from the physical one; rather, it is the physical properties that are "subtracted." What remains is the mathematical object. For further discussion on this matter, see Ugaglia (2017). On the term αφαίρεσις and its usage in mathematics, see Mueller (1990) and the bibliography cited there.

[37] The idea of space as a separate entity, studied in its own right, is a relatively modern invention. According to Euclid, there are objects with their properties and relationships, and it is geometry that deals with these things, eventually evolving into the study of space in much more recent times. For further insight on this topic, see De Risi's works from 2015 (introductory essay) and 2021.

as understood in Newtonian physics.[38] According to Aristotle, space is not a distinct entity detached from bodies; rather, it is a property inherent in objects, manifested as extension.

If Aristotle does not require a self-existent space to accommodate objects, it is reasonable to assume that he also does not require a self-existent time to accommodate movements. It is plausible to conceive of time existing in a similar manner to space, as a property. However, unlike space, time is not a property of objects but of movements. Aristotle himself emphasizes this distinction, forming the basis for his analysis of time in *Physics* IV.[39]

Consequently, we can now address the question that initiated this discussion: what happens when we consider a natural movement apart from its physical attributes? What we obtain is something that transcends both movement and time, yet bears a connection to both. I refer to this phenomenon as the *successiveness* of movement.[40]

Similar to how space manifests itself as the extension of a physical body, time consistently manifests itself as the *successiveness* of a physical movement.[41]

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[38] Space does not exist in the form of either a place or a void, according to Aristotle. In relation to the first point, Aristotle dismisses the definition of place as a three-dimensional extension occupied by a body, as discussed in *Physics* IV 1-5. Instead, he presents a concept of place as the immovable boundary or surface that separates bodies (place is the first, immovable limit of the container: τὸ τοῦ περιέχοντος πέρας ἀκίνητον πρῶτον, τοῦτ' ἔστιν ὁ τόπος in *Phys.* IV 4.211b20-21). It is crucial not to succumb to the temptation of situating the surface within space, as this would undermine Aristotle's argument and render the new definition entirely futile and redundant. Regarding the second point, Aristotle rejects the definition of void as a three-dimensional extension devoid of matter, as discussed in *Physics* IV 6-9. No alternative definition is proposed because the concept of an empty extension is demonstrated to be incompatible with the very definition of motion. For further exploration of this matter, see Ugaglia (2004).

[39] *Phys.* IV 11.219a1-10.

[40] Here, it is important to note that I am not talking about a specific extent, but rather the property of extension itself. While a cube may accidentally have a volume of 3 cubic meters, the property of being extended goes beyond that. Similarly, the cube may be red, but the property of having color is separate. I will revisit this point in Section 3.4 below, where I will delve into the distinction between successiveness and duration.

[41] In simpler terms, and using non-Aristotelian language, we can say that while motion has a direction and cannot be reversed, successiveness can occur in reverse. To put it in more everyday terms, Aristotle does not envision an arrow of time, but rather an arrow of motion. Unlike the arrow of time, which can be reversed at the level of kinematics and gains its directionality through thermodynamic considerations, Aristotle's cosmos has an inherent

2.2 Successiveness

I have chosen to label as "successiveness" what Aristotle refers to as "the before and after in movement." It represents something that is not movement itself, yet is intrinsic to it:[42]

ἔστι δὲ τὸ πρότερον καὶ ὕστερον ἐν τῇ κινήσει ὃ μέν ποτε ὂν κίνησις [ἐστιν]· τὸ μέντοι εἶναι αὐτῷ ἕτερον καὶ οὐ κίνησις (*Phys.* IV 11.219a19-21).
The before and after in motion identical in substratum with motion yet differs from it in being, and is not identical with motion.

I have opted to use the term "successiveness" for two specific reasons. Firstly, I want to avoid explicitly referring to "before" and "after" in a temporal sense, as it would create a circular argument. Secondly, I sought a term that explicitly captures the logical operation of transitioning to the next, akin to constructing the concept of n+1 based on n. This transition is closely tied to what remains of a natural movement when all qualitative determinations are subtracted from it.[43]

Movement entails a progression from one state to a different state, occurring continuously and forming a cohesive whole that is entirely defined by its purpose and its relationship to the initial point – the mover-movable

orientation that dictates the direction of motion. It is precisely because the cosmos is oriented that motion is oriented (see n. 18 above).

[42] When identifying what Aristotle refers to as the "before and after" in motion (τὸ πρότερον καὶ ὕστερον ἐν τῇ κινήσει) as a structured orientation determined by the "now," I am not proposing anything groundbreaking. This concept, extensively explored in White (1992), has been more recently revisited by several authors. I would like to highlight the work of Roark (2013), who associates the "now" with a "kinetic cut" and derives the orientation of the structure from the motion itself, viewed as a trajectory towards a specific goal. Similarly, Sentesy (2018) identifies the "now" as an ongoing division (mark off) of the motion and derives the orientation of what he terms the "prenumeric oriented continuity of motion" from the inherent characteristics of the moving object. What I contribute is the conceptual leap between a motion, which is a physical object, and its successiveness, which is a mathematical object.

[43] Although it is beyond the scope of this article, it would be interesting to compare Aristotle's perspective, which situates this structure within motion, with that of Brouwer, who places it within the mind. Brouwer argues that our idea of transitioning to the next exists in our mind, which exists in time. In contrast, Aristotle suggests that we exist in time because we possess the idea of transitioning to the next, which resides within motion. For a comparative analysis of Aristotle's and Brouwer's views on time and infinity, see Bernini & Ugaglia (forthcoming).

connection, so to speak. Without this relationship, movement ceases to exist, according to its very definition. However, for a relationship to exist, there must be properties or characteristics that are brought into correlation. Now, let us envision setting aside or subtracting all these qualitative determinations. What remains is something that still retains a trace of the fact that movement entails progress from one state to a different one, yet no longer possesses the physical attributes associated with movement.

In particular, it allows for divisibility without obstacles. Let us consider a natural movement, for example, the ripening of a fruit. While it is evident that this movement involves a transition from non-red to red, when we examine the movement itself as a physical object, it becomes difficult to further analyze its nature. As discussed in Section 1.2.1, we can observe that the endpoints – the initial state A of non-red and the final state Ω of red – are in a before/after relationship, with the process of becoming red, denoted as m, occurring in between. In this transitional phase, we can generally say that the fruit is in the process of ripening. Only at the end can we declare that the fruit is fully ripe.

However, if we set aside the physical characteristics of the movement – in this case, disregarding the color aspect – and shift our perspective from viewing it as a physical movement to considering it as mere successiveness, we can imagine dividing it without disrupting its essence. This allows us to introduce the notion of an internal point. At such a point, where we imagine interrupting the successiveness of a movement, we cannot say that the object is in a certain state of the movement because successiveness is foreign to such characterizations. However, we can say that the object is "in the now" (*ἐν τῷ νῦν*)[44] indicating that it is in between a before and an after of the successiveness of that movement. This can be applied to any point, with each "now" of the object defining a distinct division of before and after within the sequence.

Thus, the "now" (*νῦν*) is not an independent entity, but should be understood as a property of the moving object. We can consider it as the property which remains when we disregard all the qualitative aspects of the movement.

[44] In *Phys*. VI 3, Aristotle discusses the property of being in the now (*ἐν τῷ νῦν*, 234a24, 31, 34), see also n. 65 below.

When representing successiveness, a segment becomes a more suitable depiction. Similar to a segment, and unlike a movement, successiveness can be divided at any point, generating different divisions of before and after. By focusing on a specific "now," let's say B, we can discuss a before B and an after B, and by changing the point of focus, we introduce a different before/after division – for example, the before of Γ and the after of Γ.

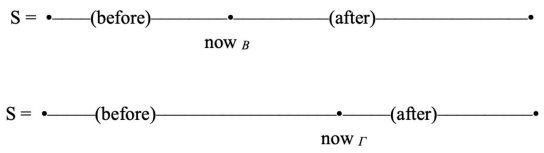

Figure 5

At this level, we notice that what separates the before from the after is no longer an extended state of movement, as we saw in the case of movement itself, but rather the "now" of the object, which is an unextended point.

Furthermore, the order of before and after in successiveness although made possible by operating within the framework of a specific movement driven by a specific purpose, no longer carries any trace of that purpose. By disregarding all the qualitative aspects of movement, successiveness becomes a mathematical structure that remains the same everywhere. At this point, there is nothing left to distinguish different movements and say, for example, "this is a translation, this is an alteration, this is a generation."

While this may not immediately strike us as significant, it holds great importance in Aristotle's system, where objects of different natures cannot be compared, and attempting to do so would be nonsensical. Generation and growth, chromatic variation and translation, even rectilinear and circular motion cannot be compared.[45]

However, once we recognize a common underlying structure in movement – any movement – a meaningful comparison becomes possible: the movements themselves may be incomparable, but their successiveness can be

[45] The various types of motion are described in *Physics* III 1-3, especially at 201a11-19. Rectilinear and circular motion are discussed in *Phys.* VIII 8-9. On the impossibility of comparing non-homogeneous magnitudes, see B. Vitrac's introduction to Euclid's *Elements*, *Book V* (Vitrac 1994), and Mueller (1981) pp. 118-51.

put on equal footing. Moreover, successiveness allows us to consider *kinesis* and *energeia* in a similar way.

2.3 Successiveness and Structure of the Perfect

In the previous Sections, I compared Aristotle's language for *kinesis*, or proper movement, and for *energeia*. He speaks of *kinesis* as a whole, using present (or imperfect) tense verbs when referring to being within the movement, and perfect (or pluperfect) tense verbs when referring to the endpoint. To speak in the perfect tense, one needs to identify a point, a division within the action, from which to observe the movement. It is for this reason that in Greek one can speak of *energeia* in either the present or the perfect tense, since *energeia*, unlike *kinesis*, is divisible everywhere.

But what about movement when it is not considered in itself as movement, but rather from the perspective of its successiveness, stripped of all physical characteristics? As a mathematical structure, successiveness is divisible everywhere: we can imagine identifying a point – a division – that represents the "now" of the movable and defines a partition of before/after, or an order of before-now-after.

In contrast to the nature of movement itself, which I associated with the structure of the present, I propose associating movement as successiveness with the structure of the perfect. The movable that is "in the now" finds itself in a state that can be seen as the culmination of the preceding successiveness (or the beginning of the subsequent one), and, as such, it can be described in the perfect tense, though with some caution.

The perfect tense takes on a different meaning when applied to these internal points than when referring to the actual culmination or goal of a movement. While using the perfect tense to describe an internal point in the sequence of a movement might imply its role as the endpoint of a process – the segment of movement that precedes it in the before/after order of its successiveness – this endpoint is merely fictional. Within the successiveness, the perfect tense signifies the internal completion of a certain action, but it cannot convey the actual fulfillment or how the action manifests externally. It is a perfect tense used exclusively in a resultative sense.

Aristotle adopts this perspective, examining movement as succession and the "now" as expressed in the perfect tense, when discussing movement not as a physical entity but as a mathematical trajectory. For instance, in *Physics* VI 6, while comparing the velocities of two objects, he observes that:

> δεδειγμένου δὲ τούτου φανερὸν ὅτι πᾶν τὸ κινούμενον ἀνάγκη κεκινῆσθαι πρότερον. εἰ γὰρ ἐν τῷ ΧΡ πρώτῳ χρόνῳ τὸ ΚΛ κεκίνηται μέγεθος, ἐν τῷ ἡμίσει τὸ ὁμοταχῶς κινούμενον καὶ ἅμα ἀρξάμενον τὸ ἥμισυ ἔσται κεκινημένον. εἰ δὲ τὸ ὁμοταχὲς ἐν τῷ αὐτῷ χρόνῳ κεκίνηταί τι, καὶ θάτερον ἀνάγκη ταὐτὸ κεκινῆσθαι μέγεθος, ὥστε κεκινημένον ἔσται τὸ κινούμενον (236b32-237a2).
> And now that this has been proved, it is evident that everything that is in motion must have been in motion before. For if that which is in motion has traversed the distance KL in the primary time TR, in half the time a thing that is in motion with equal velocity and began its motion at the same time will have traversed half the distance. But if the thing whose velocity is equal has traversed a certain distance in the same time, the original thing that is in motion must have traversed the same distance. Hence that which is in motion must have been moved before (with minor changes to Barnes' translation).

When applied to the final point Ω, the perfect tense not only denotes the culmination of the movement, but also denotes the initiation of a state where the completion of the movement extends beyond its immediate confines. In this sense, we can say that the perfect tense carries a dual significance: it captures the stative aspect of the action, indicating that its fulfillment reaches beyond itself and produces external consequences.

Without this external dimension, when considering the successiveness of individual movements, each action would remain temporally confined, encapsulated within its own boundaries. However, in order to discuss the "external" aspect of the movement, it becomes necessary to introduce the notion of time, which I will further explore in Section 3.

3. Time

In the first part of this article, I analyzed motion in its aspectual nature. Drawing on Aristotle's language, I identified two distinct perspectives and corresponding expressions: motion itself, which I correlated with the structure of present, and motion as successiveness, which I associated with the

structure of perfect. I emphasized that the successiveness of motion does not yet constitute time.

In this second part, I will move from the notion of successiveness to that of time, thus shifting the focus from the aspectual qualities of the verbal system to the temporal aspects.

3.1 Structure of Time

According to Aristotle, the before and after – which I have referred to as the successiveness – belongs to motion. I have interpreted this viewpoint as an invitation to perceive the inherent successiveness of a natural motion in a similar way to how we perceive the geometric structure of a physical object. In this sense, it can be said that successiveness represents what remains of motion once its physical characteristics are subtracted.

However, time encompasses more than that. Time is not simply the before and after of motion, it is the before and after of motion as something countable:

τὸ δὲ πρότερον καὶ ὕστερον ἐν κινήσει ἐστίν· χρόνος δὲ ταῦτ' ἐστὶν ᾗ ἀριθμητά ἐστιν (*Phys.* IV 14.223a28-29).
The before and after are attributes of movement, and time is these qua countable.

Or, in other words, it is the number of motion in respect of before and after.

ὅταν δὲ τὸ πρότερον καὶ ὕστερον, τότε λέγομεν χρόνον· τοῦτο γάρ ἐστιν ὁ χρόνος ἀριθμὸς κινήσεως κατὰ τὸ πρότερον καὶ ὕστερον (*Phys.* IV 11.219a30-b2).
On the other hand, when we do perceive a 'before' and an 'after', then we say that there is time. For time is just this – number of motion in respect of 'before' and 'after'.

In what way is time a number? And what is the relationship of this number to successiveness?

My proposition is to understand the term "number," when applied to the successiveness of a motion, in analogy with the concept of number as it relates to the continuity of a body. The connection between number and continuity is expounded by Aristotle in Book III of the *Physics*, where he argues for the potential infinity of number. According to Aristotle, number

is potentially infinite because the potential divisions of the continuous are infinite.[46]

The idea is simple yet impactful. Take a segment, divide it in half, and designate this division as "one"; then continue dividing each subsequent half and assigning them numbers like "two," "three," and so forth. Since the segment is continuous, this process can be deemed infinite, thus allowing the number to be considered infinite without necessitating the existence of an actual infinity:[47]

ἐπὶ δὲ τὸ λεῖον ἀεὶ ἔστι νοῆσαι· ἄπειροι γὰρ αἱ διχοτομίαι τοῦ μεγέθους· ὥστε δυνάμει μὲν ἔστιν, ἐνεργείᾳ δ' οὔ, ἀλλ' ἀεὶ ὑπερβάλλει τὸ λαμβανόμενον παντὸς ὡρισμένου πλήθους. ἀλλ' οὐ χωριστὸς ὁ ἀριθμὸς οὗτος τῆς διχοτομίας. (*Phys.* III 7.207b11-14)
But in the direction of largeness it is always possible to think of a large number; for the number of times a magnitude can be bisected is infinite. Hence this infinite is potential, never actual: the number of parts that can be taken always surpasses any definite amount. But this number is not separable by the process of bisection.

Although the immediate purpose of this argument is to present a form of infinity that aligns with the constraint of a finite universe, it also sheds light on the broader relationship between number and continuity or, more specifically, between number and extension. Let us consider a physically extended object in one dimension. By stripping away its physical characteristics, we arrive at a continuum. As we divide this continuum, we encounter the concept of number.

In this sense, we can say that number is the number of extension. It is important to note that here, number does not refer to the measurement of the object, but rather to the possibility to divide the continuum and establish the series of numbers.

Now, if we shift our focus to a movement instead of an object, and strip away its physical characteristics, we are left with what I have termed "successiveness." By drawing an analogy, we can state that the time of a movement is the number of its successiveness. However, unlike a static number, time, as the

[46] The number that appears in the definition of time is usually related to the characterizations of number that Aristotle employs in the *Metaphysics*, which apply only to finite sets (see, for example, Sentesy 2018, pp. 284-6).
[47] For Aristotle, the division of the continuum is the paradigmatic example of an infinite process, from which all other forms of infinity allowed in his cosmos can be derived. For more on this topic, see Ugaglia (2018).

number of movement, somehow retains the notion of transitioning to the next. I therefore introduced the term "successiveness" to capture this idea.

Counting the successiveness of a movement involves discerning the distinction between two instances of "now" in the movable, understanding how the phrase "the movable is in the now" differs when applied to different divisions of the successiveness. As we have subtracted all the physical attributes of the movable in transitioning from movement to successiveness, the difference cannot be a physical one. It is purely a mathematical difference that separates the steps in the process of transitioning to the successive. It is important to note that this does not imply the passage of time; rather, it is the movement itself that progresses from n to n+1, while time simply registers its manner.[48]

Postponing to Section 3.4 for further considerations on the relationship between number (of motion) and infinity, I will now analyze how Aristotle describes the operation by which the concept of time emerges through counting the before and after of movement. As previously mentioned, a key aspect is recognizing the difference – no longer physical but purely mathematical – between two instances of "now" in the movable. It is not only necessary to identify a "now," but also to grasp how it remains the same in a certain sense – always the one to which we refer as "I am in the now" – while also being different.

This is a non-trivial operation that engages perception, memory and imagination:[49]

ἀλλὰ μὴν καὶ τὸν χρόνον γε γνωρίζομεν ὅταν ὁρίσωμεν τὴν κίνησιν, τῷ πρότερον καὶ ὕστερον ὁρίζοντες· καὶ τότε φαμὲν γεγονέναι χρόνον, ὅταν τοῦ προτέρου καὶ ὑστέρου ἐν τῇ κινήσει αἴσθησιν λάβωμεν. ὁρίζομεν δὲ τῷ ἄλλο καὶ ἄλλο ὑπολαβεῖν αὐτά, καὶ μεταξύ τι αὐτῶν ἕτερον·

[48] No order relation is implied in the process of dividing the continuum: once the first division is fixed, you can carry out the second one anywhere, before or after, and so on for all subsequent divisions. However, in the case of motion, you are constrained to proceed with the division following the inherent order of before and after within the motion. After all, time is not just the number of motion but the number of motion according to before and after.

[49] For a detailed description of this operation, see White (1992) pp. 76-90 and the similar formulation in Sentesy (2018) pp. 300-2. Based on these, both authors arrive at an interpretation of time as measurement, with which I disagree (see Section 3.4 below). However, regarding the role of imagination, I recommend consulting Roark (2012).

ὅταν γὰρ ἕτερα τὰ ἄκρα τοῦ μέσου νοήσωμεν, καὶ δύο εἴπῃ ἡ ψυχὴ τὰ νῦν, τὸ μὲν πρότερον τὸ δ' ὕστερον, τότε καὶ τοῦτό φαμεν εἶναι χρόνον (*Phys.* IV 11.219a22-30).
But we apprehend time only when we have marked motion, marking it by before and after; and it is only when we have perceived before and after in motion that we say that time has elapsed. Now we mark them by judging that one thing is different from another, and that some third thing is intermediate to them. When we think of the extremes as different from the middle and the mind pronounces that the 'nows' are two, one before and one after, it is then that we say that there is time, and this that we say is time.

Aristotle delves deeper by clarifying how the two instances of "now" should be grasped – not as the "now" that separates the before and after, but as two separate occurrences of the term "now" in the statement "the movable is in the now." It is through this distinction that we arrive at the notion of time as the number of movement:

τὸ γὰρ ὁριζόμενον τῷ νῦν χρόνος εἶναι δοκεῖ· καὶ ὑποκείσθω. ὅταν μὲν οὖν ὡς ἓν τὸ νῦν αἰσθανώμεθα, καὶ μὴ ἤτοι ὡς πρότερον καὶ ὕστερον ἐν τῇ κινήσει ἢ ὡς τὸ αὐτὸ μὲν προτέρου δὲ καὶ ὑστέρου τινός, οὐ δοκεῖ χρόνος γεγονέναι οὐδείς, ὅτι οὐδὲ κίνησις. ὅταν δὲ τὸ πρότερον καὶ ὕστερον, τότε λέγομεν χρόνον· τοῦτο γάρ ἐστιν ὁ χρόνος ἀριθμὸς κινήσεως κατὰ τὸ πρότερον καὶ ὕστερον (*Phys.* IV 11.219a30-b2).
For what is bounded by the 'now' is thought to be time – we may assume this. When, therefore, we perceive the 'now' as one, and neither as before and after in a motion nor as the same element but in relation to a 'before' and an 'after', no time is thought to have elapsed, because there has been no motion either. On the other hand, when we do perceive a 'before' and an 'after', then we say that there is time. For time is just this – number of motion in respect of 'before' and 'after'.

If we want to use the familiar framework, keeping in mind the necessary precautions, we find ourselves in the following situation:

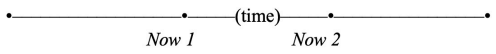

Figure 6

The successiveness – that is, the before/after of movement – once counted or capable of being counted is referred to by Aristotle as time.

3.2 Time and Successiveness

Based on what has been stated so far, since successiveness is a characteristic of individual movements, it follows that time is also inherent to each individual movement. Are there, then, as many instances of time as there are movements? Or does the relationship that connects the "nows" of a single movement, allowing them to be counted, have a broader scope that extends to different movements and different objects?

In *Physics* IV 14, towards the end of his analysis, Aristotle states that time that is "together" (ἅμα) is one and the same, and so there must be times that are not together.[50] This undeniably suggests an affirmative answer, as further supported by the following passage from *Physics* VIII. This argument not only corroborates the hypothesis that time can extend beyond the confines of an individual movement but also explains the mechanisms and reasons behind this expansion:

> εἰ οὖν ἀδύνατόν ἐστιν καὶ εἶναι καὶ νοῆσαι χρόνον ἄνευ τοῦ νῦν, τὸ δὲ νῦν ἐστι μεσότης τις, καὶ ἀρχὴν καὶ τελευτὴν ἔχον ἅμα, ἀρχὴν μὲν τοῦ ἐσομένου χρόνου, τελευτὴν δὲ τοῦ παρελθόντος, ἀνάγκη ἀεὶ εἶναι χρόνον. τὸ γὰρ ἔσχατον τοῦ τελευταίου ληφθέντος χρόνου ἔν τινι τῶν νῦν ἔσται (οὐδὲν γὰρ ἔστι λαβεῖν ἐν τῷ χρόνῳ παρὰ τὸ νῦν), ὥστ' ἐπεί ἐστιν ἀρχή τε καὶ τελευτὴ τὸ νῦν, ἀνάγκη αὐτοῦ ἐπ' ἀμφότερα εἶναι ἀεὶ χρόνον. ἀλλὰ μὴν εἴ γε χρόνον, φανερὸν ὅτι ἀνάγκη εἶναι καὶ κίνησιν, εἴπερ ὁ χρόνος πάθος τι κινήσεως (*Phys.* VIII 1.251b19-27).
>
> Now since time cannot exist and is unthinkable apart from the now, and the now is a kind of middle-point, uniting as it does in itself both a beginning and an end, a beginning of future time and an end of past time, it follows that there must always be time; for the extremity of the last period of time that we take must be found in some now, since in time we can take nothing but nows. Therefore, since the now is both a beginning and an end, there must always be time on both sides of it. But if this is true of time, it is evident that it must also be true of motion, time being a kind of affection of motion.

The concept is that while a movement has a beginning and an end, determined by its physical characteristics, the notion of a final step in a successiveness is inconceivable. To put it in more Aristotelian terms, it is impossible to have a now that marks an end but not a beginning. However, since time is a property of movement and not an independent entity, the only way to avoid the end of time is by avoiding the end of movement. There must exist an infinite movement, in which time is inherent.

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[50] ὁ αὐτὸς γὰρ χρόνος καὶ εἷς ὁ ἴσος καὶ ἅμα· εἴδει δὲ καὶ οἱ μὴ ἅμα (*Phys.* IV 14.223b3-4).

In Aristotle's cosmos, such a natural movement exists, encompassing all the movements within the sublunary world. Aristotle sees these movements as integral parts of a unified and ordered cosmic cycle, governed by the rotation of the celestial sphere.[51] From the perspective of movement itself, which is inherently physical and teleological, the individual components of the cycle form a naturally heterogeneous sequence. To perceive them as "pieces" of a singular movement we must reason in terms of successiveness, where the order is purely mathematical, enabling comparison and connection.

Thus, not only do individual movements possess their own before/after structure and, when counted, a time, but the fact that these individual movements contribute to an infinite cyclical motion allows their distinct structures to be seen as interconnected pieces of a unified before/after structure. Once identified and numbered, the "nows" of one movement can be related to the "nows" of others.

In particular, Aristotle states that movements which overlap, that is, occur together (ἅμα), share the same time.[52] In this case, there are multiple distinct objects that are "in the now", where "being in the now" is the exact same predicate for all, regardless of their differences in subject. From this perspective, the before/after of the entire set of movements in the cosmos is something universal – as Aristotle says, time is the same everywhere[53] – even though it results from the before/after of the individual movements.

Let us refer to this before/after, when applied to a "now" of this set of movements, as past/future. And let us say that the "now" of time is the limit separating them. What we obtain is an image of time as commonly perceived and expressed in everyday language.

Now, let us take any movement, defined by its own successiveness, that is, by its own order of before/after, and apply to its endpoints the considerations presented in *Physics* VIII 1. This operation allows us to read that movement in time – that is, within the successiveness of the entire set of sublunary

[51] *GC* II 10, *passim*; *Phys.* II 1.193a27-28. The process and its relation to the movement of the celestial sphere are discussed in Ugaglia (2022). Regarding the choice to interpret time as a property of this movement rather than the rotation of the heavens, see also Sentesy (2018).
[52] οὕτω δὲ καὶ τῶν κινήσεων τῶν ἅμα περαινομένων ὁ αὐτὸς χρόνος (*Phys.* IV 14.223b6-7).
[53] *Phys.* IV 14.223b10-12.

movements – without implying the existence of a separate and self-subsistent "container". From an Aristotelian perspective, a movement is in time because its local structure of before/after is part of a global structure, that of the cycle of sublunary changes. Furthermore, since time is composed of countable "nows," placing a successiveness in time provides its measure, that is, the duration of the movement.

Therefore, not only does a movement have a time, meaning it possesses a structure of countable successiveness, but it exists within time, meaning it has a duration:[54]

ἐπεὶ δ' ἐστὶν ὁ χρόνος μέτρον κινήσεως καὶ τοῦ κινεῖσθαι, μετρεῖ δ' οὗτος τὴν κίνησιν τῷ ὁρίσαι τινὰ κίνησιν ἢ καταμετρήσει τὴν ὅλην (ὥσπερ καὶ τὸ μῆκος ὁ πῆχυς τῷ ὁρίσαι τι μέγεθος ὃ ἀναμετρήσει τὸ ὅλον), καὶ ἔστιν τῇ κινήσει τὸ ἐν χρόνῳ εἶναι τὸ μετρεῖσθαι τῷ χρόνῳ καὶ αὐτὴν καὶ τὸ εἶναι αὐτῆς, ἅμα γὰρ τὴν κίνησιν καὶ τὸ εἶναι τῆς κινήσεως μετρεῖ, καὶ τοῦτ' ἔστιν αὐτῇ τὸ ἐν χρόνῳ εἶναι. καὶ τοῦτ' ἔστιν αὐτῇ τὸ ἐν χρόνῳ εἶναι, τὸ μετρεῖσθαι αὐτῆς τὸ εἶναι, δῆλον ὅτι καὶ τοῖς ἄλλοις τοῦτ' ἔστι τὸ ἐν χρόνῳ εἶναι, τὸ μετρεῖσθαι αὐτῶν τὸ εἶναι ὑπὸ τοῦ χρόνου (*Phys.* IV 12.220b32-221a9).

Time is a measure of motion and of being moved, and it measures the motion by determining a motion which will measure the whole motion, as the cubit does the length by determining an amount which will measure out the whole. Further to be in time means, for movement, that both it and its essence are measured by time (for simultaneously it measures both the movement and its essence, and this is what being in time means for it, that its essence should be measured).[55]

I will address the difference between time and duration, and the related distinction between number and measure, in Section 3.4.

3.3 Time and Grammar

In Section 2.2, I linked the successiveness of a movement to the structure of the perfect tense, asserting that identifying a moment in the successiveness – a "now" of the object that separates a before and an after – enables us to construe that point as the aim of the preceding "segment" of the

[54] *Phys.* IV 12.220b32-222a9.

[55] Here, Aristotle states that the being of motion is measured by time: τοῦτ' ἔστι τὸ ἐν χρόνῳ εἶναι, τὸ μετρεῖσθαι αὐτῶν τὸ εἶναι ὑπὸ τοῦ χρόνου. Elsewhere, when discussing the "placement" of an intrinsic successiveness in time, that is, indicating the duration of a motion, Aristotle speaks of the "when first" of that motion. In *Physics* VI 5, he discusses the "when first" (ὅτε πρῶτον) of a motion in analogy to the "where first" of an object, that is, the place that contains it.

(successiveness of) movement. This is why it can be expressed in the perfect tense. I also noted that the perfect tense primarily carries a resultative connotation.

In Section 3.1, I discussed the transition from successiveness to time, expanding the before/after relationship to encompass any number of points or "nows." Even when considering these points individually, we can employ the perfect tense, which assumes (also) a temporal significance: I state that something "has been" because it comes before something that is presently occurring, irrespective of whether there is a definite outcome achieved.[56]

Here, the points are not merely perceived as endpoints but as "nows" positioned within a reference framework constituted by the movement's beginning and end.

This perspective applies within any individual successiveness, where we may establish connections between "segments" of the same movement by assigning numbers to their endpoints. However, what occurs when we attempt to extend this line of reasoning to encompass the entirety of movements, that is, time as a whole?

3.3.1 Topological Considerations

Let us now revisit the concept of movement itself, which I depicted as an open segment, arguing that its endpoints are limits but do not belong to it. Graphically speaking:

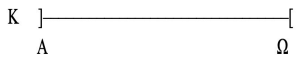

Figure 7

I then associated open segments with verbs in the present tense, and the limits of these open segments with verbs in the perfect tense, highlighting how they are simply two different perspectives on the same subject. As for these limits, I briefly mentioned without delving into it that the left limit A belongs to the

[56] Regarding the relationship between the three uses of the perfect tense see Chantraine (1926) and above n. 33.

state preceding the movement, while the right limit Ω belongs to the state following it.[57] But what exactly does Aristotle say about this limit?

The issue of Ω's status is raised by Aristotle in *Physics* VI 3. Here, he states that if the "now" is the common boundary between the past and the future, and if a thing can move throughout the entire past and remain at rest throughout the entire future, then we encounter a paradox. It arises from the fact that in this common boundary, which belongs to both the past and the future, that thing must simultaneously move (as it is the extreme of the first time) and remain at rest (as it is also the extreme of the second time). In other words, we face the absurdity that Ω must belong to the movement and yet also to the state that follows the movement.

ἔτι δ' εἰ τὸ αὐτὸ μέν ἐστι τὸ νῦν ἐν ἀμφοῖν τοῖν χρόνοιν, ἐνδέχεται δὲ τὸν μὲν κινεῖσθαι τὸν δ' ἠρεμεῖν ὅλον, τὸ δ' ὅλον κινούμενον τὸν χρόνον ἐν ὁτῳοῦν κινηθήσεται τῶν τούτου καθ' ὃ πέφυκε κινεῖσθαι, καὶ τὸ ἠρεμοῦν ὡσαύτως ἠρεμήσει, συμβήσεται τὸ αὐτὸ ἅμα ἠρεμεῖν καὶ κινεῖσθαι· τὸ γὰρ αὐτὸ ἔσχατον τῶν χρόνων ἀμφοτέρων, τὸ νῦν (*Phys.* VI 3.234a34-b5).
Moreover, inasmuch as it is the same now that belongs to both the times, and it is possible for a thing to be in motion throughout one time and to be at rest throughout the other, and that which is in motion or at rest for the whole of a time will be in motion or at rest in any part of it in which it is of such a nature as to be in motion or at rest: it will follow that the same thing can at the same time be at rest and in motion; for both the times have the same extremity, viz. the now.

Regardless of the fact that Aristotle refers to it as the "whole," which can be understood as complete with its boundary, what I have previously labeled as "closed" in order to align with the terminology used in topology, the essence of the matter is that if we were to confine ourselves to considering only closed intervals, the issue of limit points would become unsolvable.

However, this argument is revisited and elegantly resolved in *Physics* VIII 8, where Aristotle asserts that even though the same limit exists, it should be understood as belonging to "the succeeding state" of the movable:

δῆλον δὲ καὶ ὅτι ἐὰν μή τις ποιῇ τοῦ χρόνου τὸ διαιροῦν σημεῖον τὸ πρότερον καὶ ὕστερον ἀεὶ τοῦ ὑστέρου τῷ πράγματι, ἔσται ἅμα τὸ αὐτὸ ὂν καὶ οὐκ ὄν, καὶ ὅτε γέγονεν οὐκ ὄν. τὸ σημεῖον μὲν οὖν

[57] In our language, Ω is the extremal point of motion and the minimum of completed motion. In more Aristotelian terms, there is no ultimate instant of motion (= the present), but there is a first instant of having finished moving (= the perfect). *Phys.* VI 5.235b6-236a7, cf. *Phys.* VIII 8.263b9-15 mentioned below.

ἀμφοῖν κοινόν, καὶ τοῦ προτέρου καὶ τοῦ ὑστέρου, καὶ ταὐτὸν καὶ ἓν ἀριθμῷ, λόγῳ δ' οὐ ταὐτόν (τοῦ μὲν γὰρ τελευτή, τοῦ δ' ἀρχή)· τῷ δὲ πράγματι ἀεὶ τοῦ ὑστέρου πάθους ἐστίν (*Phys.* VIII 8.263b9-15).

It is also plain that unless we hold that the point of time that divides earlier from later always belongs only to the later so far as the thing is concerned, we shall be involved in the consequence that the same thing at the same moment is and is not, and that a thing is not at the moment when it has become. It is true that the point is common to both times, the earlier as well as the later, and that, while numerically one and the same, it is not so in definition, being the end of the one and the beginning of the other; but so far as the thing is concerned it always belongs to the later affection.

In other words, Aristotle clarifies that the limit Ω should be attributed to the state that follows the movement, rather than being simultaneously attributed to both the movement and the subsequent state.

Using our terminology, while the point Ω remains unique, it should be ascribed to the state that succeeds the movement, resulting in a closed interval on the left side, while the movement remains open-ended on the right side, as anticipated:

Figure 8

Now, let us turn our attention to the point Ω, considering it not only as the endpoint of the preceding movement but also as the beginning of the subsequent state. In this case, the Greek language employs the perfect tense to describe Ω, indicating that it represents not just the conclusion of the movement but, more importantly, the commencement of the state where the completion of the movement extends beyond its immediate context. In this sense, we can say that the perfect tense carries a stative value, signifying that the culmination of an action has repercussions that transcend the action itself.

Consequently, the stative perfect tense is not limited solely to the point Ω but encompasses the entire interval of which Ω serves as the lower boundary. This allows us to establish a correspondence between the perfect tense and a closed interval on the left side or, more broadly, between stative verbs and closed intervals on the left:

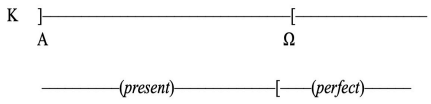

Figure 9

Based on this, we can depict movements and states on a line divided into open and closed intervals:

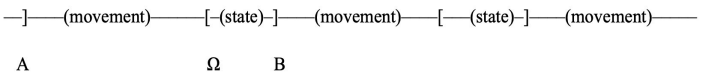

Figure 10

These intervals are associated with different verb forms. For instance, when discussing the open interval AΩ, I use the present tense. However, when referring to the point Ω, I have the option to use either the perfect or the present tense. I employ the perfect tense if I perceive it as the boundary of the preceding movement; but I can choose between the present and the perfect tense if I consider it as a point within the subsequent state. In a broader sense, I can interchangeably use the present or the perfect tense, depending on the context, to denote the closed interval ΩB. Similarly, for the point B, I utilize the perfect tense when referring to it as the limit of the following movement; but I can opt for either the present or the perfect tense if I regard it as a point within the preceding state. This pattern continues throughout.

3.4 Time vs *Duration*

In Section 3.1, I proposed interpreting Aristotle's reference to number in his definition of time in light of the concept of number as the number of divisions of the continuum (*Phys.* III 7.207b11-14). I briefly mentioned that in both cases, the term "number" should not be taken in the improper sense of measurement. Now, to support my thesis, I will add some observations related to Aristotle's conception of the infinite.

Of course, the time of a movement also implies a duration. Once you have identified two distinct "nows," you can consider what lies between them, which Aristotle still refers to as time, as a measure of the movement,

just as you can consider what lies between two divisions of the continuum as a measure of extension. In this sense, time is continuous.

However, time is not solely duration, and Aristotle is careful to distinguish between the two. Although he does not employ separate terms, the intended meaning becomes evident from the semantic context:[58] time is always associated with number, while duration pertains to measurement.[59] But why is it crucial to keep time and duration distinct?

To address this question, let us revisit Aristotle's position concerning the infinite, starting from the previously mentioned passage from Physics III 7, and focusing on the final sentence:

ἐπὶ δὲ τὸ λεῖον ἀεὶ ἔστι νοῆσαι· ἄπειροι γὰρ αἱ διχοτομίαι τοῦ μεγέθους· ὥστε δυνάμει μὲν ἔστιν, ἐνεργείᾳ δ' οὔ, ἀλλ' ἀεὶ ὑπερβάλλει τὸ λαμβανόμενον παντὸς ὡρισμένου πλήθους. ἀλλ' οὐ χωριστὸς ὁ ἀριθμὸς οὗτος τῆς διχοτομίας (*Phys.* III 7.207b11-14).
But in the direction of largeness it is always possible to think of a large number; for the number of times a magnitude can be bisected is infinite. Hence this infinite is potential, never actual: the number of parts that can be taken always surpasses any definite amount. But this number is not separable by the procedure of bisection.

The final clarification regarding the inseparability of the infinite number from the process of division is crucial for understanding Aristotle's notion of potential infinite, which is always related to some procedure. We can certainly stop the procedure at a certain point and obtain a number – say, seven – that can also be attributed to other things like a group of horses or stars. However, no matter how large we make this number, it will always be finite. In contrast, when we talk about the infinite number, we are specifically referring to the number of divisions of the continuum, or of the steps of another permissible infinite process within Aristotle's cosmos.

[58] In *De caelo*, a similar situation arises concerning the distinction between weight as a quality (what we would call specific weight) and weight as a quantity (what we refer to as absolute weight). Although Aristotle uses the same term, the difference becomes clear from the semantic context: absolute weight is always accompanied by a term related to measurement. I have addressed this issue in Ugaglia (2015).

[59] The necessity to distinguish between number and measurement is discussed in detail in Cavagnaro (2002) and Coope (2005). While providing a compelling analysis in many respects, Sentesy (2018), on the other hand, reintroduces the overlap between number and measurement, time and duration ("time is the number of motion, an extent measured out by two nows that limit and define it – an extent taken as though it were indivisible," p. 303).

In Aristotle's cosmos, actual infinity does not exist, neither in terms of size (there are no infinitely extended objects) nor in terms of quantity (there are no infinitely large sets of objects). Therefore, we cannot "obtain" an infinite number by counting an infinite number of objects that simply do not exist. The only way to "obtain" it is by counting the steps of an infinite process connected to a finite object (like a segment in the case of division).

Now, let us consider a different scenario. Instead of a segment, imagine we have a circle with a finite radius. Let us visualize a uniform circular motion occurring on the circle and try to count the revolutions. Since the motion is periodic, it is inherently infinite, and the act of counting becomes infinite as well. However, because the circumference on which the motion takes place is finite, this type of motion aligns perfectly with Aristotle's conception of the cosmos.

Like the process of dividing the continuum, the counting number is potentially infinite. However, in this case, since it counts a movement, this infinite number is nothing but the time of that infinite movement.

Just as the infinite number is inseparable from the process itself, the infinite time is inseparable from the periodic motion it counts. In my interpretation, this motion refers to the cycle of sublunary movements, but the same applies to the rotation of the celestial sphere. The important thing is the existence of a natural periodic infinite motion that can be counted.

Although the motion is circular – returning to itself after a period – the number that counts its "nows" never repeats itself. In this sense, we can say that time is infinite and it is linear.

It is now clear that this reasoning applies to the number, and it is evident why Aristotle's concept of time can be infinite and linear when defined as a number. If instead time were merely a measure, namely an extension, some problem would arise concerning how this extension can be said to be infinite. Indeed, while Aristotle acknowledges that numbers can be infinite towards the large, he explicitly denies that extension can be.[60]

[60] I note that while we can affirm that the rotation of the celestial spheres has a time, we cannot affirm, except in an improper sense, that it is within a time, meaning that it has a duration. For something to be within a time, there must be a time that contains it, which is not the case in this instance. Similarly, we can only affirm, again in an improper sense, that the cosmos is within a place (*Phys.* IV 5.212b7-22).

For this reason, I lean towards the view that when he says "number", he means it in the literal sense and not as a figure of speech for "measure".

3.4.1 Number vs *Measure*

But what does this reasoning amount to if we consider a different system from Aristotle's? The rationale I just presented in support of understanding time as a number is closely tied to the finite nature of Aristotle's cosmos and his unique conception of the infinite. Once we move beyond finitude or loosen the constraints on the infinite, the necessity of understanding time as a number diminishes, and a more "natural" notion of time as a measure can be reintroduced.

However, once we remove the reference to number, which, as we have seen, is intimately linked to the concept of division in Aristotle's framework, the significance of the unextended "now" – a division, in essence – becomes less prominent. It can ultimately be replaced with the idea of an extended present, which aligns better with the verbal system.

This is in a sense what happens in Stoic philosophy. The Stoics rejected both Aristotle's definition of time as a number and the notion of the νῦν as a limit. By redefining time as an interval,[61] they introduced the concept of an extended present (ἐνεστὼς παρατατικός) to replace the unextended "now" that Aristotle sought to address. Consequently, they developed a framework that Hoffmann describes as "a present of physical time isomorphic to the value of the extended verbal present."[62]

The convergence of time and extension, along with its connection to the verbal system, reached its culmination in Neoplatonic philosophy when Damascius defined time as the "measure of the duration of being" (μέτρον τῆς τοῦ εἶναι παρατάσεως). Here, the term παράτασις is directly borrowed

[61] διάστημα τῆς τοῦ κόσμου κινήσεως *SVF* II 510.

[62] Hoffmann (1983) p. 6. See, in particular, the discussion of the passage in Priscian where the dilation of the present moment is justified by invoking Aristotle himself, who understood the present moment not only as a limit (πέρας) that separates the past and the future but also as a conjunction (συνέχεια, *Phys.* IV 13.222a10-12) that holds them together. Unlike the limit, which is necessarily punctual, the conjunction (*iuncturam*) can be seen as something extended that holds the past and the future together (*ibid*., p. 7).

from grammar and serves as the technical term for describing the durative aspect of the verb.

For a more detailed exploration of the path leading from the Stoic definition to the Neoplatonic interpretation, specifically through the lens of grammar, I recommend consulting Hoffmann's article, which provided the foundation for the present article. It is worth noting that Damascius firmly believed that his interpretation aligned with Aristotle's true intentions.[63]

Interestingly, this brings us full circle. We began with Aristotle's definition of time in relation to motion, suggesting that it draws heavily on the analysis of how the Greek language, particularly its verbal system, describes motion. And now, we find ourselves back at that very definition, reinterpreted within a Neoplatonic framework and illuminated by the same linguistic factors, which have been partially formalized through the study of grammar. The main difference lies in the fusion and complementarity of philosophy and grammar in Neoplatonic discourse, whereas they remained distinct in Aristotle's analysis.

As I have attempted to demonstrate in this article, Aristotle was careful to distinguish between the realm of motion itself, which is discussed in terms of pure aspect and characterized by the notion of an extended present, and the realm of motion as successiveness, where the speaker's concern extends beyond aspectual matters to include temporal relations of before and after. While both perspectives involve the examination of the same object, that is, motion, Aristotle takes great care to keep them separate. Importantly, he never conflates the two meanings of "now" when referring to these respective domains, a distinction that is usually evident from the context.

For instance, when Aristotle says, "Now I am walking," it is clear that he is employing the term "now" in reference to the extended present, pertaining to the motion itself rather than its temporal aspect. Conversely, when he asserts that "now" signifies the demarcation between the before and after of a motion (or, more broadly, the past and future), he is addressing the successiveness of motion or, in a broader sense, the concept of time. In this

[63] Damascius read Aristotle in light of Pseudo-Archytas, whom he considered a primary source. It was indeed Pseudo-Archytas who interpreted number and interval as synonymous, both referring to measure understood as order. See Hoffmann (1983) p. 19.

context, "now" should be understood as the unextended[64] boundary where nothing is in motion.[65]

Aristotle seems to have been the first to realize that in order to understand the relationship between motion and time, it was necessary to separate the two realms. By doing so, he manages to keep a part the definition of time from the perception of time. The perception of time has to do with duration and with the extended present. The definition of time focuses on successiveness and on the unextended "now". The inclusion of the semantic domain of numbers and counting, which belongs to the realm of time but is foreign to that of motion, is crucial to this separation.

However, the difficulty of the subject matter, the dialectical nature of the argument as presented in *Physics* IV, and the apparent constraints that this mode of reasoning imposes on language gradually leads to a decrease in references to numbers among developments of Aristotle's conception. Reference to numbers will be replaced by an emphasis on measurement. Because of this seemingly innocent semantic shift, which appears to be supported by putative Aristotelian origins, the two levels of discourse will once again converge. Simultaneously, the distinction between aspect and verb, recognized by Aristotle in linguistic observations but not yet codified, will be formalized by grammarians and used by Neoplatonic philosophers, not to keep the levels apart, but to unite them.

[64] Aristotle introduces a different terminology for the "now" of time understood in a proper sense, which is called "by itself" (καθ'αὐτό), and for the present of common language, which is called "according to another" (καθ' ἕτερον): "And it is also necessary that the now, not the one called according to another but by itself and primarily, be indivisible" (Ἀνάγκη δὲ καὶ τὸ νῦν τὸ μὴ καθ' ἕτερον ἀλλὰ καθ'αὑτὸ καὶ πρῶτον λεγόμενον ἀδιαίρετον εἶναι, *Phys.* VI 3.233b33-34).

[65] Consider the opposition between being in motion and being "with respect to something" (κατά τι) introduced in *Physics* VI and used to resolve Zeno's paradox of the arrow. In time, it can be said that something is in motion but not that it is κατά τι, whereas in the now, it can be said that it is κατά τι but it makes no sense to say that it is in motion (see especially *Phys.* VI 3.234a25-b9 and VI 8.239a36-b3).

4. Conclusion

In this paper, I have delved into Aristotle's concept of motion, exploring it at three distinct levels:

1) Motion in itself: natural motion considered in its entirety, characterized by its teleological orientation and qualitative aspects.

2) Successiveness: what remains of that motion outside of a physical perspective.

3) Time: the counted successiveness, interlinked with one another.

Alongside these levels of analysis, I have identified three verbal structures associated with them:

1) Structure of present: actions are considered as actions, with a discernible ontological order of before and after. The beginning of motion is designated as before, while its end is labeled as after. Before and after are separated by an extended present.

2) Structure of perfect: by reducing actions to mathematical objects, an internal division emerges, establishing a sequential order of before and after. This temporal distinction is now represented by a punctual "now," which is the "now" of a specific movable.

3) Structure of time: in the action, reduced to a mathematical object, two or more divisions are identified, and the focus is on the relationship between these divisions, which are counted. The relationship is extended to divisions belonging to different successiveness, that is, different motions. Consequently, the local order of before and after expands into a universal sense of past and future. The past and the future are demarcated by a punctual "now," representing the unextended present for all objects moving together.

If we consider the logical-ontological plane and ask what comes first, then level (1) is the most foundational because it underlies the others: (1) serves as the base from which we derive (2), and from (2) we derive (3). However, if we shift our focus to the epistemological plane and ask which level better explains the structural order of change, then (3) takes precedence, and the sequence is reversed: in (3), the order is expressed in general terms, in (2) in specific terms, and in (1) it is not yet articulated.

Furthermore, as we move from (1) to (3), from the level of motion as motion to the level of motion as time, there is an increasing amount of

analysis and reevaluation applied to observation, resulting in the emergence of a greater clarity in the structure of order. The more we mediate the original data regarding motion, the clearer the order becomes.

Does all of this imply that time is subjective? Or perhaps less objective than motion? To put it in more Aristotelian terms: if time is number and the soul is what counts, can there be time without a soul?

As mentioned earlier, I do not claim to have an answer to this question. What I argue is that the type of response one chooses to give to this question is closely tied to the response one would give to the question: can there be mathematical objects in the absence of a soul?

Certainly, it can be affirmed that even in the absence of a soul, there are physical objects, including mathematical ones. However, they are not distinct entities, but rather inseparable except in the realm of thought. Likewise, it can be asserted that even without a soul, there is motion, and thus, the logical structure of motion exists, which I have referred to as successiveness. It is an inherent aspect of motion, not separate from it, and, like mathematical objects, inseparable except in the realm of thought, that is, in the soul.

This seems to be what Aristotle himself implies when addressing the question regarding the relationship between time and the soul:

> πότερον δὲ μὴ οὔσης ψυχῆς εἴη ἂν ὁ χρόνος ἢ οὔ, ἀπορήσειεν ἄν τις. ἀδυνάτου γὰρ ὄντος εἶναι τοῦ ἀριθμήσοντος ἀδύνατον καὶ ἀριθμητόν τι εἶναι, ὥστε δῆλον ὅτι οὐδ᾽ ἀριθμός. ἀριθμὸς γὰρ ἢ τὸ ἠριθμημένον ἢ τὸ ἀριθμητόν. εἰ δὲ μηδὲν ἄλλο πέφυκεν ἀριθμεῖν ἢ ψυχὴ καὶ ψυχῆς νοῦς, ἀδύνατον εἶναι χρόνον ψυχῆς μὴ οὔσης, ἀλλ᾽ ἢ τοῦτο ὅ ποτε ὂν ἔστιν ὁ χρόνος, οἷον εἰ ἐνδέχεται κίνησιν εἶναι ἄνευ ψυχῆς. τὸ δὲ πρότερον καὶ ὕστερον ἐν κινήσει ἐστίν· χρόνος δὲ ταῦτ᾽ ἐστὶν ᾗ ἀριθμητά ἐστιν (*Phys.* IV 14.223a21-29).
>
> Whether if soul did not exist time would exist or not, is a question that may fairly be asked; for if there cannot be someone to count there cannot be anything that can be counted either, so that evidently there cannot be number; for number is either what has been, or what can be, counted. But if nothing but soul, or in soul reason, is qualified to count, it is impossible for there to be time unless there is soul, except that there could be that, whatever it is, by being which time is, i.e. if movement can exist without soul. The before and after are attributes of movement, and time is these qua countable (with minor changes to Barnes' translation).

So, if mathematical objects exist without a soul to bring them forth, then the successiveness of motion also exists without soul. Otherwise, if mathematical objects are created by a soul, and do not exist without a soul, also the successiveness is created by a soul, and does not exist without the soul.

Therefore, accepting the idea that mathematical objects do not depend by a soul, I am inclined to assert that at least up to level (2), we are dealing with something objective. The question that remains is regarding level (3), specifically time in its proper sense. It might indeed require an intellect capable of numbering, much like the concept of number itself when understood as the potentially infinite divisions of the continuum.

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