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# CONCEPTUAL MODELS OF PHYSICS IN LINGUISTIC FORCE DYNAMICS

The paper offers a critical scrutiny of Leonard Talmy's comparison of linguistically coded Force Dynamics and modern physics (Talmy 2000 : 456-459). It is argued that six out of seven 'differences' mentioned by Talmy are in fact similarities between the naive (linguistic) and the scientific conceptualization of forceful interaction. We have also found that one of the notions of Talmy's Force Dynamics- *the intrinsic force tendency*- has no counterpart in either pre-Newtonian theories of force (Aristotle, Philoponus) or intuitive (folk) physics, richly accounted for in numerous empirical studies (e.g., Champagne et al. (1980), Larkin et al. (1980), McCloskey (1983), Halloun et al. (1985), Hammer (1995), diSessa (1988, 1993, 1996)).

## 1. Introduction

Force Dynamics, one of the crucial frameworks of cognitive linguistics, was developed by Leonard Talmy (1976, 1988, 2000), who described it as one of the key schematic systems organizing language and cognition, with both close class (modals, prepositions, conjunctions) and open class representation, allowing us, for example, to replace the causative with finer distinctions like letting, hindering, helping, obstructing, etc. (Talmy 2000: 409). Talmy's ideas were adopted by, for example, Sweetser (1982, 1991), Johnson (1987), Jackendoff (1990), Chun & Zubin (1990), Brandt (1992), Deane (1992), Achard (1996), Boye (2001), Vandenberghe (2002), Da Silva (2003) and Loureiro-Porto (2009).

As the notion of force is essential in both naive and modern physics, it is difficult to avoid comparing the concept of force coded in language with that of physical force, which is central for both Newtonian and pre-Newtonian physics. Leonard Talmy (2000: 455) states that

> [...] conceptual models within linguistic organization have a striking similarity to those evident in our naive world conceptions, as well as to historically earlier scientific models [....] however, these basic conceptual structures often diverge substantially from the fully rigorous conceptions of contemporary science.

He then proceeds to enumerate the differences between the linguistically and conceptually manifested Force Dynamics and modern physics (2000: 456-459), taking into account the concepts of:

1. privilege- the fact that one of the participants (the Agonist) has a privileged status,
2. stationariness- action (movement) and rest have unequal status,
3. strength- one of the participants (Agonist or Antagonist) is stronger,
4. schematic reduction – linguistic description of force interaction is simplified and does not include the continuous process but only some stages of it,
5. lack of causality – a form of schematic reduction excluding a cause of the event,
6. blocking, letting, resistance and overcoming- the qualities which, according to Talmy, have no counterparts in physics,
7. tendency- the intrinsic force tendency of the Agonist.

The features enumerated in points (1)-(7), according to Talmy, put linguistic Force Dynamics at variance with contemporary physics. In the following sections we will discuss the above seven “points of divergence” and argue that six of them constitute similarities, rather than differences between the two. Let us start with the concept of the privileged position of one of the participants of the forceful interaction.

## 2. The privileged position of the Agonist

Talmy claims that in linguistically coded interaction one of the participants is always focused upon, which is not the case in modern physics:

> In force dynamics, the “Agonist” concept confers on one object in an interaction a privileged status and special characteristics not shared by its opposite, the “Antagonist”, even where these two are otherwise equivalent. While this imparity is so natural in language-based conceptualizing, it has no counterpart in physical theory. There, equivalent objects have the same properties: there is no physical principle for differentiating equivalent objects according to “privilege”. (2000: 456)

On the contrary, physics has many ways of focusing attention on one of the participants of the interaction. A typical example is the physical analysis of a falling stone, which in fact involves two participants: the stone (the Agonist) and the planet Earth (the Antagonist) but the second participant is rarely mentioned, despite the fact that the stone pulls the Earth with equal and opposite force and as a result of this interaction the planet also moves (albeit infinitesimally small distance) in the direction of the stone. In addition, one of the most important models, used in many branches of physics (mechanics, wave physics, particle physics, astronomy, etc.), is called *harmonic oscillator*.

An example (an approximation) of a harmonic oscillator can be a pendulum. But when we describe the oscillations of a pendulum (the Agonist) we usually do not mention the other participant of the interaction – the planet Earth. To give one more example, the concept of gravitational or electromagnetic field[1] is a way of focusing attention only on one entity on which a force (field) of unspecified origin acts. Such physical quantities as the intensity of electrostatic or gravitational field, which equal the force acting on a unit of charge or mass at a certain point in space, allow the physicists to focus attention on only one participant (the Agonist) of forceful interaction.

We can sum up our discussion so far by stating that the privileged position of the Agonist, i.e. focusing of attention on only one of the participants of interaction, is a feature of both conceptual Force Dynamics and physics. In the next section we will discuss the next point of apparent divergence between Force Dynamics and Physics- the concept of the unequal status of movement and rest.

## 3. The unequal status of movement and rest

Talmy claims that one of the differences between conceptual Force Dynamics and physics lies in the fact that in the latter ‘stationariness is not a distinct state set apart from motion, but is simply zero velocity’ (2000 : 456). We do not agree with Talmy for several reasons. Firstly, the state of rest in an inertial frame of reference means not only zero velocity but also, for example, zero momentum, zero acceleration and zero resultant force. Secondly, a stationary body (material point) has no trajectory or, more specifically, its trajectory is reduced to a point, as opposed to a moving body, whose trajectory is a 3-dimensional curve. It is true that constant motion and rest have the same status with reference to the absence of resultant force, according to the first law of Newtonian Mechanics[2] but Newtonian laws should never be considered in separation from one another because they create a consistent and unified whole. The second law can be interpreted as “accelerated motion is always accompanied by Force” thus clearly stating the difference between motion and rest as the presence or absence of a resultant force. Finally, a branch of Mechanics, called Statics, which is so important in the construction of buildings and bridges, deals specifically with the stationary state. The construction engineers, who base their calculations on the physical equations of Statics, would certainly be alarmed if they learned that, according to physics, there is no difference between stationariness and motion. In the next section we will focus on the concept of relative strength of the Agonist and Antagonist in Force Dynamics and physics.

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1 The concept of *field* is the central notion of an important branch of physics called *the field theory.*

2 For this and further references to Newtonian Mechanics, see for example: Halliday et al. (2009: 87-105).

## 4. The greater relative strength of one of the participants

Talmy suggests that the difference between conceptual Force Dynamics and physics lies in the greater strength of one of the participants of forceful interaction over another.

> Next consider the linguistic force-dynamic concept of greater relative strength, represented in our diagrams with a plus sign. […] So natural is this linguistic, and perhaps also commonsense conception that it may escaped special attention during our exposition. Yet, it is at variance with one of the more familiar principles of physics, that two interacting objects […] must be exerting equal force against one another. If one of the objects exerted a stronger force […] the pair of object would accelerate in the direction of the force. (2000 : 456)

Unfortunately, the above quotation represents one of the most common misconceptions concerning the 3rd law of Newtonian Mechanics, which can be expressed by the following formula:

$$\vec{F}_{AB} = -\vec{F}_{BA} \tag{1}$$

The better to understand it, let us imagine two sumo fighters pushing against each other. In accordance with Formula (1), the forces each of them exerts against his or her opponent are equal. If we stopped here, we would have to conclude (like Talmy) that none of them can win. But we have also to take into account that each of the fighters pushes not only against their opponent but also against the ground, which pushes them back with equal force. The stronger fighter exerts a greater force against the ground and wins because the two forces acting on him or her in opposite directions (the reaction of the ground and the force exerted by the other fighter) are not equal. So, as we can see, Newtonian Mechanics does allow us to describe a stronger entity, which allows us to conclude that there is no difference between Force Dynamics and modern physics in this respect. In the next section we will discuss the concept of *schematic reduction*.

## 5. Schematic reduction

According to Talmy, the conceptual schematisation has no counterpart in physics. For example, the sentence ‘The heat broke the guitar’ describes only the initial and end states[3] of what in reality is a very complex process involving a continuum of infinitesimal changes.

[3] More specifically, Talmy refers to it as ‘tripartite structure: a static prior state, a discrete state transition, and a static subsequent state’ (2000: 457).

> Linguistic structures […] ''chunk'' the complexities and continuities of occurrence into this simplified schema and, in this, may well parallel conceptual patterns of naive physics. In scientific physics, by contrast, causation involves a continuum of interactions occurring at the finest scale of magnitude: there is no operative physical principle of ''chunking.'' (2000 : 457)

On the contrary, "chunking", modelling (schematization), macroscopic description, approximating, idealising, and simplifying are standard and essential tools in all branches of physics. The necessity of building idealized models of the physical reality stems from the staggering complexity of the latter. The most general division of physics, reflected in the structure of many university departments, is into experimental and theoretical physics. Theoretical physicists build mathematical, idealized models of reality based on the experimental data, which are then tested further by experimental physicists. Consider, for example, the following set of basic macroscopic physical quantities: area, volume, mass, density, temperature, heat, entropy, pressure, amperage, voltage, electrical resistance, condenser capacitance, luminous intensity and viscosity. All those quantities allow us to discard the microscopic, intricate structure of substances and their division into molecules, atoms, electrons, protons, neutrons, quarks, gluons, muons, neutrinos and the whole zoo of other elementary particles. Even when describing an object as simple as a pulley, the physicists usually assume that the string is weightless and inflexible and the pulley is frictionless. All physical theories (models) contain such simplifying assumptions. To give one more example, one of the basic models of physics is the ideal gas, which consists of non-interacting and randomly moving point-particles but still reflects the properties of real gases quite well under normal temperature and pressure conditions. It may seem, given the ever increasing speed of computer processors, that simplification and modeling will soon no longer be necessary. The fastest supercomputer (AD 2014) has the computing power of about $10^{16}$ FLOPS (floating point operations per second) which may be considered impressive until we realize that two grams of molecular hydrogen contain about $10^{23}$ molecules, each of which interacts with $(10^{23} – 1)$ other molecules. The number of interactions is therefore of $10^{46}$ order of magnitude, which makes our supercomputer about $10^{30}$ (1000000000000000000000000000000) times too slow to simulate the trajectories of the molecules in two grams of hydrogen in real time. Therefore, physicists have to rely on simplified models, like the aforementioned 19th century[4] ideal gas model.

Summing up this point of our discussion, schematic reduction, simplification, approximation and modeling constitute the essence of physics and in this respect account rather for similarity and not divergence of conceptual Force Dynamics

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[4] The ideal gas model was created by Kronig in 1859 but the macroscopic properties of gasses were quite well researched as early as 17th century by, for example, Robert Boyle, who published his famous law ($pV$=const.) in 1662.

and physics. In the next section we will discuss a specific form of schematic reduction, namely focusing only on certain stages of an event.

## 6. Schematic reduction excluding the cause of an event

Talmy (2000: 458) gives examples of sentences like 'The book toppled of the shelf' or 'the ball sailed through the window' to explicate what he claims to be yet another instance of the differences setting Force Dynamics and physics apart. Neither of the two sentences highlights the cause of the movement. We do not know why the book toppled off the shelf or what sent the ball sailing through the window. Talmy considers it to be another form of schematic reduction to which we referred in point 5.

> In a second form of schematic reduction to which language subjects causality, an "event" – that is, a portion conceptually partitioned out of the continuum of occurrence- can be represented as existing outside of causality altogether. (2000: 457)

According to Talmy, it puts the conceptual Force Dynamics in 'direct contrast with the perspective of physics, in which everything is an unbroken causal continuum' (2000: 457). However, as we already stated when considering points 1. and 5., 'conceptual partitioning out of the continuum of occurrence' (ibid.) is an essential method of physics, reflected, for example, in its division into various branches like mechanics, acoustics, electrodynamics, physics of fluids, plasma physics, solid state physics, atomic physics, molecular physics, nuclear physics, particle (high-energy) physics, cryogenics, optics, thermodynamics, etc. Each of those sub-disciplines focuses on different aspects of what Talmy refers to as 'the continuum of occurrence'. For example, atomic physics concentrates on an atom as an isolated system but does not concern itself with the structure of the atomic nucleus, which is the subject of nuclear physics, or with the way groups of atoms connect into molecules, which in turn is the concern of molecular physics. When electrons leave the structure of the atom, they become the focus of attention of the particle physics. And when the atoms bond into gas, liquid or crystal they come into the scope of the physics of fluids and solid state physics. When the gaseous, liquid or solid state substances are heated, thermodynamics steps in, and when they are cooled to extremely low temperatures- cryogenics. Each of the numerous branches of physics uses a specific set of mathematical models and experimental methods, which are only partially and to different degrees connected with one another. The viable 'theory of everything', as theoretical physicists call it (for example, Weinberg 1993), has yet to be constructed.

To sum up this point of our discussion, 'the unbroken causal continuum' (if it exists) is absent both in the conceptual Force Dynamics and physics. In the next section we discuss the notions of blocking, letting, resistance and overcoming in Force Dynamics and physics.

## 7. Blocking, letting, resistance and overcoming

Talmy claims that the concepts of blocking, letting, resistance and overcoming have no equivalents in physics, because the latter lacks the notion of 'entityhood' and intrinsic tendency towards motion or rest.

> Significantly, some of the most basic force-dynamic concepts- blocking and letting, resistance and overcoming- have no principled counterpart in physics. For their viability, these concepts depend on the ascription of entityhood to a conceptually delimited portion of the spatiotemporal continuum, and on the notion of an entity's having an intrinsic tendency toward motion or rest. (2000: 458)

Talmy then uses a physical example of water in a tank to illustrate his point.

> For example, the plug in a tank of water can be seen as ''blocking'' flow, and its removal as ''permitting'' flow, only if one conceptualizes the water as a unified entity with tendency toward motion, the space below the plug as an entity that the water has the potential to occupy, and the plug as a unitary entity in between. These concepts of blocking and letting vanish, however, under physics' fine-structural perspective of individual particles and forces in local interaction. (2000: 458)

Let us start with the notion of 'entityhood', which according to Talmy is absent in physics. We have to admit finding Talmy's statement rather surprising. The main goal of physics is describing reality, which is populated with objects (entities), and this task would be impossible if the concept of an object (entity) was not present in physical description of the world around us. For example, a fluid (e.g., water in Talmy's example above) can be described as a macroscopic entity with certain global properties, as the following quotation clearly demonstrates.

> A fluid, in contrast to a solid, is a substance that can flow. Fluids conform to the boundaries of any container in which we put them. They do so because a fluid cannot sustain a force that is tangential to its surface […] it can, however, exert a force in the direction perpendicular to its surface. (Halliday et al.: 359)

We have collected several other quotations from Halliday et al. (2009)[5] to demonstrate how physicists use the notion of 'entityhood' and combine it with the concepts of 'blocking, letting, resistance and overcoming', which according to Talmy 'have no operation in physical systems' (2000: 458). The quotations

[5] *Fundamentals of Physics* by David Halliday, Robert Resnick and Jearl Walker, used by generations of studens, is one of the most popular handbooks of physics, which has already had nine editions and has been recently published in the Kindle (e-book) format.

come from various branches of physics, such as mechanics, electrodynamics, electromagnetism, thermodynamics, physics of fluids and nuclear physics.

a. the concept of blocking (preventing)

During the descent, air was released from tanks **to prevent** water from flooding the chamber (Halliday et al. 2009: 531)
A cylindrical copper rod of length 1.50 m and radius 2.00 cm is insulated **to prevent** heat loss through its curved surface. (Halliday et al. 2009: 559)
The weight *W* of a body is the magnitude of the net force required **to prevent** the body from falling freely, as measured by someone on the ground. (Halliday et al. 2009: 95)

b. the concept of letting (allowing)

When we pull two charged particles of opposite signs away from each other, we say that the resulting electric potential energy is stored in the electric field of the particles. We get it back from the field by **letting** the particles move closer together again. (Halliday et al. 2009: 811)
What is the least coefficient of static friction between the cat and the merry-go-round that will **allow** the cat to stay in place, without sliding? (Halliday et al. 2009: 134)
A pitot tube (Fig. 14-48) is used to determine the airspeed of an airplane. It consists of an outer tube with a number of small holes *B* (four are shown) that **allow** air into the tube. (Halliday et al. 2009: 383)

c. the concept of resisting

We have assumed that the air through which the projectile moves has no effect on its motion. However, in many situations, the disagreement between our calculations and the actual motion of the projectile can be large because the air **resists** (opposes) the motion (Halliday et al. 2009: 68)

By Lenz's law, whether you move the magnet toward or away from the loop in Fig. 30-1, a magnetic force **resists** the motion, requiring your applied force to do positive work. (Halliday et al. 2009: 797)

d. the concept of overcoming

The force that controls the motions of atomic electrons is the familiar electromagnetic force. To bind the nucleus together, however, there must be a strong attractive nuclear force of a totally different kind, strong enough **to overcome** the repulsive force between the (positively charged) nuclear protons (Halliday et al. 2009: 1173)

> We see then that fission will occur only if the absorbed neutron provides an excitation energy *E*n great enough **to overcome** the barrier. This energy *E*n need not be *quite* as great as the barrier height *Eb* because of the possibility of quantum-physics tunneling. (Halliday et al. 2009: 1200)

What the above quotations clearly exemplify is the fact that the concepts of 'entityhood' as well as the notions of 'letting, blocking, resistance and overcoming' are indispensable in physics and are not merely used for 'convenience of conceptualization' (Talmy 2000: 458).

In the next section we will focus on what Talmy terms as *the intrinsic force tendency of the agonist*. This time we will have to agree that, indeed, this crucial feature of Talmy's Force Dynamics has no counterpart in modern physics. Unfortunately, Talmy is wrong claiming that it correlates in any way with the pre-Newtonian theories of force, especially Aristotelian *natural tendencies*.

## 8. The intrinsic force tendency of the Agonist

Talmy claims that his *intrinsic force tendency* is congruent with naive physics and contradictory with modern physics:

> Further, in terms of the cognitive structure of language, an object in a given situation is conceptualized as having an intrinsic force tendency, either toward action or toward rest. This concept appears to correlate with historically earlier scientific theories involving an object's impetus in motion or a tendency to come to rest. The concept, however, is at considerable variance with modern physics. (2000: 456)

First of all, Talmy's description of forceful interaction does not 'correlate' and is in fact contradictory with pre-Newtonian theories of force. The idea that bodies and substances have natural tendencies either toward rest or toward motion comes from Aristotle (4th c. BC), according to whom massive bodies on Earth had a tendency to rest and light bodies (like fire) had a tendency to move upwards. Superficially, it may seem that Talmy's 'intrinsic force tendency', which is either 'toward rest' or 'toward action', correlates with the theory of Aristotle; however, there is a crucial difference between the two because Aristotle's natural tendencies are stable, whereas Talmy's 'intrinsic force tendencies' change. For example, Talmy (2000: 416) analyses the force-dynamic patterns in the following sentences:

a. The ball kept rolling because of the wind blowing on it.
b. The shed kept standing despite the gale wind blowing against it.
c. The ball kept rolling despite the stiff grass.
d. The log kept lying on the incline because of the ridge there.

The ball and the shed in examples (a) and (b), according to Talmy, have 'a tendency toward rest', while the ball and the log in examples (c) and (d) have 'a tendency toward action', which is contradictory with Aristotle's idea of natural motion tendencies. For example, the ball, as a massive body on Earth, would always have a tendency to rest, regardless of whether it is propelled by the wind, as in sentence (a), or slowed down by stiff grass, as in sentence (c). Aristotelian concept of the unified and stable tendency of all massive bodies to rest was accepted by all major pre-Newtonian and pre-Galilean theories of force[6]. For the motion to continue, a force had to be applied to overcome this natural tendency of a massive body on Earth to rest.

The concept of *impetus* was introduced by Philoponus (4$^{th}$ c. AD)[7] but only as an auxiliary theory to Aristotelian physics. Impetus was needed to explain the motion of projectiles. Since all motion was necessarily a forced motion, explaining the apparently free movement of projectiles through air posed a problem because no source of the necessary propelling force could be discerned. Aristotle suggested that the propelling force was exerted by the air displaced by the projectile. Philoponus proposed a different solution. The stone, according to him, carried an internal force, the "impetus", which propelled it forward against its natural tendency to rest. Philoponus's theory was later developed by Jean Buridan (14$^{th}$ c. AD).

> God, when He created the world, moved each of the celestial orbs as He pleased, and in moving them he impressed in them impetuses which moved them without his having to move them any more. And those impetuses which he impressed in the celestial bodies were not decreased or corrupted afterwards, because there was no inclination of the celestial bodies for other movements. Nor was there resistance which would be corruptive or repressive of that impetus. (Clagett 1959: 536)

According to Buridan, the value of impetus equals weight multiplied by velocity, which makes it a counterpart of the Newtonian concept of momentum (mass times velocity). As we can see, impetus is always a propelling force, which again is inconsistent with Talmy's idea of 'the intrinsic force tendency' which is either braking ('towards rest') or propelling ('towards action'). The concept of 'the intrinsic force tendency' is therefore inconsistent with either Aristotelian or post-Aristotelian (Philoponus, Buridan) physics.

Talmy is also wrong claiming that the concept of impetus is 'at considerable variance with modern physics'. In fact, the concept is perfectly consistent with Newtonian physics, where, as we have already mentioned above, it is called

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[6] One notable exception is the theory of Lucretius (1$^{st}$ c. BC) who claimed that all massive bodies have a tendency to move but, again, it was a stable and unified tendency, which can not therefore be considered as correlating with Talmy's changing 'intrinsic force tendencies'.

[7] See for example Clagett (1959).

*momentum*[8]. In Newtonian physics a projectile 'carries momentum' which can is understood as 'potential propelling force' because the second law of Newtonian Mechanics can be formulated as

$$\vec{F} = m\vec{a} = \frac{d\vec{p}}{dt} \tag{2}$$

which means that force equals change of momentum in a unit of time[9]. The momentum (impetus) carried by a moving body will manifest itself as a propelling force, whose magnitude and direction is given by Formula (2), opposing the braking force (for example, friction). So Philoponus and Buridan, writing about impetus, were expressing basically the same idea as Newton- impetus (momentum) is a kind of propelling force, which will manifest itself as reaction to the braking force. In fact, Aristotelian *natural motion tendency* is also consistent with Newtonian physics, because Newton would not deny that all massive bodies on Earth eventually come to rest so, in a way, they have a tendency to rest. What sets Newtonian and Aristotelian description of motion apart is not the concept of the tendency to rest, both Newton and Aristotle would agree that this is the case, but the matter of causation. Aristotle would ascribe it to a natural tendency, while Newton to external braking force; however, neither of them would agree with Talmy that massive bodies on earth have a tendency to either rest or motion (action).

Natural motion tendency is also described in modern literature on intuitive (folk) physics (e.g., Champagne et al. (1980), Larkin et al. (1980), McCloskey (1983), Halloun et al. (1985), Hammer (1995), diSessa (1988, 1993, 1996)). DiSessa mentions what he calls a *phenomenological primitive* of 'Dying away: lack of motion or activity is the natural state of inanimate objects. Any induced action or motion naturally fades, unless the agent of induction continues (as in force as mover)' (1996: 720); however, as we can see, it is a clear counterpart of the Aristotelian stable, one-directional motion tendency of all massive bodies to rest and is therefore inconsistent with Talmy's binary notion of *intrinsic force tendency* which can be either *toward rest* or *toward action*.

Let us look again at examples (a)-(d). The ball in example (a) has 'a tendency toward rest' when it is pushed by the wind but a 'tendency toward action (motion)' when it is obstructed by stiff grass. What is the justification of calling those tendencies 'intrinsic' when they seem to depend on external conditions? What would be the 'intrinsic force tendency' of the ball in the following sentence: 'The ball kept moving despite the stiff grass because of the wind.'? The ball would

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[8] Galileo, whose theory of Dynamics is fully consistent with Newton's still used the word "impetus".

[9] In fact, the differential vector Formula (2) carries more information, but it can be read in this simplified way when the motion is linear.

have to display the two tendencies simultaneously. Let us move to examples (b) and (d). The shed is wedged against the ground (through its foundations) just as the log is wedged against the ridge and therefore they both stand still despite the wind (the shed) or despite gravity (the log) and because of the foundations (the shed) or because of the ridge (the log). Why then should the shed have an 'intrinsic tendency toward rest' and the log an 'intrinsic tendency toward action'?

Summing up our remarks concerning *the intrinsic force tendency of the Agonist*, we have to conclude that this idea is inconsistent with either Newtonian, pre-Newtonian or intuitive (folk) physics, especially the Aristotelian concept of *natural motion tendencies* and the Philoponian concept of *impetus*. Talmy is also wrong claiming that the latter is at odds with modern physics. Furthermore, Talmy's notion of 'intrinsic force tendency' is not only inconsistent externally with either naïve or Newtonian physics but also internally (within Talmy's formalism).

## 9. Summary and Conclusion

In Sections 2-7 we have argued that six of the seven conceptual categories enumerated in Section 1 characterize not only conceptual Force Dynamics but also physics. Having considered the notions of privilege (focusing on the Agonist), stationariness, relative strength, schematic reduction (including lack of causality), entityhood, blocking, letting, resistance and overcoming, we had to conclude that all of them constitute a set of similarities, rather than differences between conceptual Force Dynamics and physics.

In section 8 we established that, although the notion of *natural motion tendency* and *impetus* (momentum) are present in pre-Newtonian physics and have their counterparts in modern physics, they are contradictory with Talmy's idea of changing *intrinsic force tendency*. Additionally, the latter is not accounted for in the rich body of empirically based modern literature on intuitive (folk) physics, sometimes referred to collectively as *misconceptions studies* or even *disaster*[10] *studies*.

What we tried to demonstrate is that our 'naive world conceptions' evident in language do not diverge from the 'rigorous conceptions of contemporary science' as much as Talmy anticipated (2000: 455) [11]. It is also important to point out that our findings do not undermine the viability of the linguistic Force Dynamics framework created by Leonard Talmy in any way; however, especially in view

[10] The term refers to the robust resilience of folk physics based knowledge to formal instruction

[11] The reason for the said lack of divergence between the naive (linguistic) and the scientific was explained by Lakoff and Nunez (2000: 1) in the following way: 'Mathematics as we know it has been created and used by human beings: mathematicians, physicists, computer scientists, and economists—all members of the species Homo Sapiens'. Science does not allow those who pursue it to get above the constraints of human conceptualiser.

of our argument in Section 8, it would be perhaps worthwhile to reformulate certain parts of Talmy's account, to ascertain that it is indeed fully consistent with intuitive (folk) physics.

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