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A Cognitive Study of FORCE Image Schemas

> […] *because force is everywhere*
> *we tend to take it for granted and overlook*
> *the nature of its operation.*
>
> (Johnson, 1987: 42)[1]

Abstract. In my 2022 paper on Thematic roles in image schemas, I illustrated my 2019b image schema definition with two examples: MOTION and CONTAINER. The present paper tests yet another instance of a more complex nature, FORCE and its variations. Newton's Third Law that "for every action, there is an equal and opposite reaction" means that all force variations have two force exerting objects in counterforce configuration. The relation between them can be viewed from the perspective of either one, or both, which is reflected in language structures. We experience force as intensity of contact with objects, associating it with their mass and velocity, and extrapolate our experience to external objects, assessing their force by velocity and mass. Following my 2019b definition of the image schema, and my 2022 suggestion on the function of Thematic roles in image schemas, the present paper critically reviews and reinterprets earlier analyses of forces.

Keywords: force; counterforce; image schema; Thematic roles; vantage point.

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[1] Cf. Wittgenstein's saw: "One is unable to notice something because it is always before one's eyes" (1963, p. 30).

1. Introduction

The paper analyses the concept of FORCE[2] and some of its image schematic variations commonly discussed in literature.[3] It opens with an Introduction (1.) which offers a brief account of research on the concept of FORCE, its schematic variations and basic features, and outlines the aim of the analysis. Section 2 is a brief presentation of force in physics and human experience, and a survey of force in literature. My definition of the image schema (2019b) is recapitulated in in section 3. Some problems of Thematic relations are briefly outlined in section 4. Section 5 is devoted to a critical presentation of the individual variations of the FORCE image schema that have been proposed so far. The paper closes with Conclusions and References. Conventions used in diagrammatic representations are explained in appropriate places of the text.

FORCE and its image schematic variations were extensively discussed by Johnson (1987) and Peña (1999). Johnson proposed an analysis of a number of image schematic variations of FORCE, illustrating them, however, with quite confusing, inconsistent diagrams. Peña's paper essentially repeated Johnson's descriptions except that she proposed a hierarchy where FORCE is subservient to PATH, and is a super category of COMPULSION, COUNTERFORCE, and REMOVAL OF RESTRAINT (1999, p. 205). She illustrated the variants mainly with metaphoric expressions.[4]

I adopt Resnick, Halliday, and Krane's elucidation of Newton's Third Law that "there is no such thing as a force that is not accompanied by an equal and opposite force" (1992, p. 83). It means that in our cognition, there is no image schema of FORCE itself, but only a number of different configurations of COUNTERFORCES.

My aim is to critically review FORCE image schema variations commonly listed in literature (Johnson, 1987; Peña, 1999; Hampe, 2005), in an attempt to uncover their nature, unify their descriptions and consequently

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[2] I follow Peña (1999) and Hampe (2005) in using capital letters, The forms in quotes remain unchanged.

[3] Physicists recognize many other types of forces like "suction, tension, stress, elastic forces, torques, centripetal forces and others" (Duch: e-mail communication).

[4] In 2011, I showed that all abstract entities are metaphorized in terms of physical objects, calling the process *objectification*. Langacker (1987) and other authors confusingly term this process 'reification' which is traditionally assigned to metaphorization at the lowest level of the Great Chain of Being, i.e., 'inorganic things'.

their diagrammatic representations. As will be shown, the task will involve human perception,[5] and Thematic roles of the two force exerting objects.

Any coherent description of image schemas was earlier impossible due to the lack of a definition of the image schema. Some linguists even declared, most radically Clausner and Croft, that any formulation of a definition of the image schema is impossible, except "only by enumeration" (Clausner and Croft, 1999, p. 21). However, in 2019, I formulated a definition of the image schema as "a mental structure with at least one OBJECT image schema, which is a conceptually independent entity representing physical object whose fundamental property is density experienceable by touch, with ensuing boundedness, shape, size, etc." (2019b, p. 27). My hypothesis shed new light on the problem of image schemas, opening new perspectives for their research.

Image schemas, as mental structures, are based on our subjective sensory experience, and this is one of the possible reasons that their nature and number are difficult to determine. With reference to FORCE, we typically experience it either through contact with another object, be it a blow of a fist, or a whiff of air. The assessment of the force of external objects is based on perception of their velocity, estimated weight, or the magnitude of impact by extrapolation from our own bodily experience.

My definition of the image schema, in complement with Resnick, Halliday, and Krane's statement that "there is no such thing as a force that is not accompanied by an equal and opposite force" (1992, p. 83), provide a solid basis for an approach in which any type of force is a configuration of two objects exerting force upon each other, viewed from the perspective of one or the other, or both, and each assigned appropriate Thematic role(s).

2. FORCE

2.1. Force in human experience

Of Newton's three laws of motion, it is the Third Law that seems to be essential to human experience. It states "that for every action (force) in nature there is an equal and opposite reaction. If object A exerts a force on object B, object B also exerts an equal and opposite force on object A" (*Newton's Laws*

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[5] Cf., for example, MacLaury (2002), Głaz (2002), and Beveridge and Pickering (2013).

of Motion. NASA's Glenn Research Center).[6] Naturally, this is not the way people experience and perceive force. We see force "[a]s an attribute of physical action or movement: strength, impetus, violence, or intensity of effect" (Oxford English Dictionary; henceforth, OED). For example, we easily perceive the difference between the "intensity of effect" of a medicine ball and a tennis ball hitting us at the same speed, or the difference between two tennis balls hitting us at different speeds. The greater the velocity or mass, the greater the intensity of force that our bodies feel. We extrapolate this personal experience of force to external objects other than our own bodies, and assess the intensity of force from perceptible mass and velocity. We also view these interactions from different perspectives of the two objects and, though unconsciously, assign Thematic roles[7] to them. As Beveridge and Pickering remarked in an extremely interesting paper, "[t]he number of potential embodied perspectives available for a given sentence is therefore the number of participants in that event plus that any embodied observers licensed by the comprehender's situation model. We propose that these perspectives (e.g., embodied agent, embodied patient, embodied recipient, plus embodied observer and non-embodied observer) provide a transparent basis for discussing action perspective taking"[8] (for more details on perspective, see, for example, MacLaury, 2002; Głaz, 2002; and Beveridge and Pickering, 2013).

In the present paper, these two aspects, perspective and role assignment, will constitute grounds for the description of variations of FORCE image schema.

2.2. Force in cognitive literature

Since Johnson's 1987 work, the nature of image schemas has enjoyed continuing interest among linguists – Clausner and Croft (1999), Grady (2005), Johnson (2005), Hampe (2005), Oakley (2007), Mandler and Canovás (2014), Szwedek (2018, 2019a, 2019b, 2022), to name just a few. However, except Johnson's and Peña's analyses, and my papers, the concept of FORCE has been mentioned only in passing, as just one among other image schemas. In the following sections, I will briefly mention research on force dynamics by

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[6] https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/newtons-laws-of-motion/#newtons-third-lawaction-reaction. DOA: Aug. 20, 2021).

[7] As I demonstrated in my 2022 paper, Thematic roles are integral parts of image schemas.

[8] There is no page numbering in Beveridge and Pickering's paper. The quote comes from the section "A Taxonomy of Perspectives".

Talmy (1988), image schema analyses by Johnson (1987) and Peña (1999), and my recent paper (2018) about the OBJECT image schema, its structure and participation in dynamic relations. Talmy's proposal is particularly interesting for the present paper, because it emphasizes the counterforce nature of force. It will be briefly discussed in point 2.2.1. Johnson's 1987 work is of special importance because it introduced the concept of image schema to linguistics. His analysis of force image schemas will be dealt with in point 2.2.2. Basing on Johnson's list of force image schemas, Peña (1999) proposed a hierarchy of force image schemas which will be outlined in point 2.2.3. A few reflections on my 2018 paper will be offered in point 3.1.

2.2.1. Talmy's views on force

Within the context of causality, Talmy formulated his main thesis in the following words: "[o]ne force-exerting entity is singled out for focal attention – the salient issue in the interaction is whether this entity [the Agonist] is able to manifest its force tendency or, on the contrary, is overcome. The second force entity [the Antagonist], correlatively, is considered for the effect that it has on the first, effectively overcoming it or not" (1988, p. 53). Talmy was criticized by, for example, Copley who wrote that "Talmy's requirement for force opposition works in many cases, but in other cases it is something of a stretch" (2002, p. 109). She referred to Talmy's example *Smoothing the earth helped the logs roll down the slope* "where the logs are the Agonist and the earth is the Antagonist, whose tendency to oppose the rolling of the logs is removed" (ibid.). She calls on Jackendoff (1990) as arguing that "the 'Antagonist' (which no longer antagonizes on his analysis) is the agent doing the smoothing, who provides an additional force toward or in support of the logs' tendency to roll down the slope" (ibid.: 110). Thus, when the earth has been removed, it can no longer 'anatagonize' the Agonist.[9] Also Goddard pointed out that the verbal definition of causation that Talmy proposed, is circular and obscure. Another objection he raised is the question of how different representational devices are supposed to interact with one another (1998, p. 81). Despite the criticism, Talmy's work remains an important contribution to cognitive research.

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[9] This is not entirely true, as even smooth surface of earth causes some counterforce of friction.

2.2.2. Johnson's description of force

Johnson characterizes force in terms of six features "that play a role in our sense of force":

  i.   "force is always experienced through interaction. We become aware of force as it affects us or some object in our perceptual field";

  ii.   "force has a vector quality, a directionality. […] our experience of force usually involves the movement of some object (mass) through space in some direction";

  iii. there is typically a single path of motion;

  iv.   forces have origins or sources and targets;

  v.   forces have degrees of power or intensity;

  vi.   there is always a structure or sequence of causality involved (1987, p. 42–44).

On the basis of these features,[10] Johnson describes seven image schematic variations of force: Compulsion, Blockage, Counterforce, Removal of restraint, Enablement and Attraction. However, he immediately adds that this is only "a selection of the more important image schemata that play a role in our experience of force" (1987, p. 48). The seven schemas will be analyzed in more detail in section 5.

2.2.3. Peña's hierarchy of force image schemas

In her 1999 paper, Peña proposed a hierarchy (system of subservience) of FORCE image schemas based on the following claims:

- motion is important for the PATH schema (1999, p. 189);
- "motion is caused by some kind of force" (ibid.);
- "the concept of motion cannot be understood without the notion of path" (ibid.);
- "PATH and FORCE image-schemas are interrelated" (ibid.);
- "the FORCE image-schema is dependent on the PATH schema" (1999, p. 188).

She proposed a four-level hierarchy of FORCE (subservient to PATH) in which COMPULSION, BLOCKAGE, and REMOVAL OF RESTRAINT are directly subservient to FORCE. ATTRACTION and REPULSION are sub-

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10 Somewhat odd is the word "typically" in "a single path of motion". Can a force have more than just one single path of motion?

servient to COMPULSION, and COUNTERFORCE and DIVERSION to BLOCKAGE (1999, p. 203) as shown in Fig. 1.
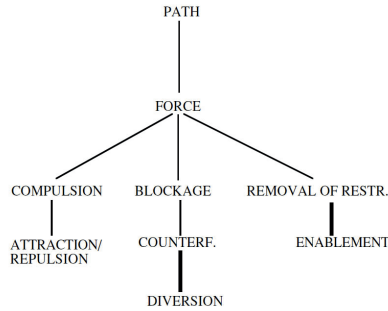

Figure 1. (Peña's Figure 1; 1999, p. 205)

What is evidently missing in the PATH diagram is MOTION, despite Peña's claim of its significance for "the PATH image-schema" (1999, p. 189), and despite the fact that it is "caused by some kind of force" (ibid.). As if contradicting herself, Peña asserted that "the concept of motion cannot be understood without the notion of path" (ibid.). She argued that since PATH has a starting point, an end point and a direction, then "if you go from a source to a destination along a path, then you must pass through each intermediate point on the path […]" (ibid.). But what she was describing is exactly what she disregarded, i.e., MOTION, caused by some kind of force along a path. In other words, force sets an object in motion, and the moving object 'draws' the path. In consequence, it is the PATH that is subsidiary to MOTION which is an element of FORCE.

In her discussion of individual FORCE variations, Peña followed closely Johnson's descriptions with two exceptions. She based her discussion on metaphorical expressions, and to the repertoire of image schemas, she added REPULSION as opposed to ATTRACTION.

3. The image schema

3.1. Szwedek's OBJECT image schema

In 2018, I published a paper in which I discussed, what I called, static and dynamic variants of the OBJECT image schema. Static OBJECT image sche-

mas include, for example, SURFACE, PART, and FRONT. Within the dynamic OBJECT image schemas, I briefly described, among others, a few image schemas of FORCE (COUNTERFORCE, ATTRACTION, REPULSION, BLOCKAGE, and DIVERSION), that is those in which "objects are dynamically involved in some action" (2018, p. 63). Basing on Langacker's (1987) division of all entities into things and relations, I wrote that "[t]he division into static and dynamic schemas reflects the basic human experiences of objects and relations between them". I added that "[f]orce is most fundamentally and directly experienced by humans through the sense of touch, that is, on contact of objects with the human body, and then extrapolated to interactions between other external objects" (2018, p. 64; cf. also Szwedek, 2000a, 2000b on the importance of touch). I also observed that "[w]e easily forget that our bodies are physical objects and that every event in our physical world consists, minimally, of objects and dynamic interactions between them" (2018, p. 63), and where there are interactions, "there must be INTERACTANTS, 'persons' or 'things' (Collins English Dictionary), since only objects have energy to exert force" (ibid.).[11]

So formulated ideas set grounds for my 2022 work on the structure of the image schema consisting of objects and relations between them, relations in which objects function as Thematic roles. My 2022 new proposal is discussed in the next section, while Thematic roles of objects in the FORCE image schemas are introduced in point 4.

3.2. Szwedek's definition of the image schema

Despite common scepticism and even denial of the possibility that the image schema can be defined, except "only by enumeration" (Clausner and Croft, 1999, p. 21), I proposed that an image schema is "a mental structure with at least one OBJECT image schema which is a conceptually independent entity representing a physical object whose fundamental property is density experienceable by touch, with ensuing boundedness, shape, size, etc." (2019b, p. 27). Although the OBJECT schema was only listed as one among all the other commonly listed image schemas, I demonstrated that it is unique. This observation was based on Langacker's distinction between conceptually independent 'things' (objects), and conceptually dependent relations. I also

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[11] See also my 2023b (in print) paper on the function that Thematic roles play in linking reality with image schemas.

adopted Langacker's reasoning that "[r]elations are conceptually dependent, i.e. one cannot conceptualize interconnections without conceptualizing the entities they interconnect" (1987, p. 215). A similar view was earlier expressed by Johnson with respect to force which […] is always experienced through interaction" (1987, p. 43; cf. Langacker's 'interconnections'). Paraphrasing Langacker (1987, p. 215), interconnections are conceptually dependent, i.e., one cannot conceptualize interconnections without conceptualizing interactants (Johnson's 'sources' and 'targets'). The conclusion was obvious: if, except the OBJECT schema, all other schemas are relational (MOTION, CONTAINER, etc.), they must contain at least one OBJECT schema anchored in the physical world. For example, MOTION is always MOTION OF X (OBJECT), and CONTAINMENT is a relation between the CONTAINER OBJECT (Johnson and Lakoff, 1980, p. 31) and the CONTAINED OBJECT.

I proposed then, that if OBJECT schemas are necessary components of relational schemas, they are natural candidates to function as Thematic roles within relational schemas, thus linking image schemas in the mind with language structures. For example, in the MOTION schema, in the basic propositional version *X moved*, X is an Agent (inanimate objects cannot initiate motion[12]), and in the transitive version, *X moved Y*, X is an Agent, and Y is Affected Entity (Szwedek, 2022, section 6.1). It is reasonable to expect that other image schemas, with FORCE schema variations among them, will also contain various arrays of Thematic roles.

3.3. A digression on the origin of image schemas

Almost all research on image schemas was so far based on the postnatal sensory experience, mainly vision (Johnson, 1987, p. 25). However, as I argued in my works (2018; 2019b; 2022, 2023a), most image schemas have their origin in the prenatal period with the sense of touch playing an all-important role.[13] This is important because most of the FORCE subcategories are contact forces where the role of touch is crucial (e.g., BLOCKAGE, FRICTION,[14] DIVERSION, PRESSURE, etc.). My thesis about the prenatal origin of image schemas is supported by Neisser's firm assertion that, biologically, "a schema is a part of the nervous system" (1976, p. 54), and Rohrer's unequivocal state-

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[12] In the absence of an Agent in such a minimal structure, X would be Theme.

[13] For details about the role of touch in human cognition, see Szwedek 2000a, 2000b, 2002, 2018, 2019b, 2022 and 2023a.

[14] Possibly the first treatise on Friction was written by Jellett in 1872.

ment that "[f]rom the perspective of neuroembriology […] sensory stimuli in general (with the obvious large exception of the visual) do not commence at birth" (2005, p. 176). He added that "[a]lthough image schemas may ultimately require the consolidation of postnatal sensorimotor experience, their origins stretch back into prenatal experience" (2005, p. 176). The nervous system and the sense of touch, which is indispensable in the perception of density, begin to develop at the same time, in the seventh week of gestation (Chamberlain, n.d., Kornas-Biela, 2011). Therefore, it is unimaginable that the first tactile stimuli would have no impact on the simultaneously developing nervous system with image schemas as its integral parts (Szwedek, 2018, p. 80, and 2019b, p. 14).

4. Thematic roles

4.1. A brief note on the history of Thematic roles

Kasper (2008) offered a good overview of Thematic roles since antiquity. He first mentioned Pāṇini's *Kārakas* which were discussed in some detail by Ganeri in his 2011 book (Ch. 3.). A *kāraka* is a semantic relation between the verb and a noun. The similarity between Pāṇini's conception and modern semanto-syntactic approaches is quite striking. Since the western philosophy and linguistics were based exclusively on the Greek and Roman tradition, it was not until Böhtlingk's *Pāninis Grammatik* (1839) that the Indian legacy was revived. However, it took 90 years more before the next significant contribution appeared. In 1930, Blake published "A Semantic Analysis of Case" in which he pointed out that, in western linguistics, the use of the term 'case' had always been used to denote only the formal relationships between a predicating element and its arguments. He argued that "no completeness of grammatical treatment is possible without recourse to the semantic approach" (Blake, 1930, p. 48). To make the distinction between morphological and semantic case clear, he labelled the morphological cases "case forms", and used the term "case" for the semantic relationship (1930, p. 35).

Blake's approach was echoed by Gruber (1965) who called Blake's "cases" 'thematic relations' such as Goal, Location, Source, Agent and Theme. Gruber is often regarded as the first to have introduced the problem into modern linguistics. His work undoubtedly set the stage for all further research on Thematic relations.

In 1968, Fillmore proposed six basic 'deep cases', Agentive, Instrumental, Dative, Factitive, Locative and Objective, but added that "additional cases will surely be needed" (1968, p. 24). His comment on the need of additional cases was confirmed by Beaugrande and Dressler (1980) who proposed over 30 concepts necessary for an adequate text analysis. They added that "[i]n general, linguists' typologies have fewer categories than ours (e.g. Fillmore, 1968; Chafe, 1970; Longacre, 1976), while those in artificial intelligence have more (e.g. Wilks, 1977a)" (1980, p. 111, ftn. 16).

Jackendoff expanded Gruber's essential list of thematic roles from his 1972 book adding the roles of Actor and Patient in his 1983 and 1990 works. He also demonstrated that one argument may have two roles at the same time, as in the sentence *The car hit the tree*, where 'the car' is a Theme and an Actor, and 'the tree' is a Patient and a Goal. Later modifications by various scholars include, among others, such roles as Experiencer, Recipient, Benefactive (or Beneficiary), Possessor, Causee, and Comitative, Affected Entity, and more.

4.2. Some difficulties with Thematic roles identification

Thematic roles have raised a lot of controversies. As Dowty observed "two perennial vexing problems with the appeal to thematic roles are (i) lack of agreement among linguists as to which thematic roles exist, and the absence of any obvious way to decide this question, and (ii) the lack of any definite way to independently justify the assignment of noun phrases to thematic roles in particular sentences" (1986, p. 340).

The topic of the present paper limits the number of objects involved in FORCE image schemas to two: FORCE and COUNTERFORCE exerting objects. In consequence, the number of Thematic roles is also limited. The major roles to consider are Agent and Patient. The Agent role was most often defined in terms of "a participant which the meaning of the verb specifies as doing or causing something, possibly intentionally" (EAGLES), or "the initiator of some action, capable of acting with volition" (Saeed, 2009, p. 153). The conjunction 'which' in the EAGLES definition seems to imply that the participants can be inanimate, though can possibly act intentionally. Saeed's definition clearly indicates animate beings.[15] However, as the example *I tried*

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[15] The question whether Bonobo or Kanzis, or other animals, show signs of intentionality or volition is outside the scope of the present paper.

to get through, but there were people blocking my way shows, human beings not always are 'intentional participants' or 'initiators acting with volition'. People cause the blocking, but most probably, as in a crowd, unintentionally.

Anderson (2018) proposed to separate Agent and Cause,[16] the latter interpreted as a participant that "shares the agentive property of causing an event to happen, but it's not aware of the event and doesn't choose to cause it, because the cause is inanimate" (Ch. 9.2.). Payne (2007) proposed to label such role "INVOLUNTARY CAUSER (Berk, p.16, simply calls the role the 'CAUSER'). […] The participant that causes an event without doing so with intention (on purpose)" (2007, p. 1). In view of such discrepancies, I have decided to use the label 'Cause' for both animate and inanimate objects, the latter such as 'wind', 'water', and indirectly force exerting objects (for example, a ball thrown by X is the cause of some damage, etc.).

The Patient role was defined as "the entity undergoing the effect of some action, often undergoing some change in state" (Saeed, 2009, p. 153) or "a participant which the verb characterizes as having something happen to it, and as being affected by what happens to it. Examples: objects of *kill*, *eat*, *smash* but not those of *watch*, *hear*, *love*" (EAGLES). However, since calling the object of killing or eating a Patient sounds quite weird to me, I will use the label 'Affected Entity'.[17] I may add that Affected Entity subsumes narrower scope roles like Experience or Beneficiary, with relevant restrictions in their definitions. Some other roles, like Location and Theme, are insignificant for the FORCE schemas because of their omnipresence. Forces are 'located' everywhere (Johnson, 1987, p. 42), and as Santorini correctly pointed out, Theme is "something of a catch-all" (2007, p. Ch.7.). Most definitions of the Theme refer to an object either in motion or in position (for example, EAGLES,[18] or Saeed (2009). For force schemas it means, that all force exerting objects are Themes, in motion or in position, and always in some location, so I decided to disregard these roles in my presentation.

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[16] https://essentialsoflinguistics.pressbooks.com/chapter/9-3-events-participants-and-thematic-roles/ (DOA: Nov. 11, 2021.

[17] The term is also used by Beaugrande and Dressler (1980, p. 95), and the phrase 'being affected' is used in the EAGLES definition. It is also present in Jackendoff's phrase 'object affected' (1983, p. 381).

[18] EAGLES defines Theme as "[a] participant which is characterized as changing its position or condition, or as being in a state or position".

5. Variations of FORCE image schemas

5.1. Problems with force variations

From the scientific point of view, we might expect that, since there is no force "that is not accompanied by an equal and opposite force", both force exerting objects would have the same sets of Thematic roles in our image schemas, as in Johnson's COUNTERFORCE example of football players described as "head-on meetings of forces" (Johnson, 1987, p. 46), when "two equally strong, nasty, and determined force centers collide face-to-face, with the result that neither can go anywhere" (ibid.).

However, in our common understanding, represented in dictionary definitions, counterforce is "[a] force that opposes another force" (Merriam-Webster Dictionary), which means that we see FORCE as composed of two counterforces. Johnson and Peña treat COUNTERFORCE and BLOCKAGE as separate schemas. The former, with two identical force exerting objects meeting "head to head", I will call MUTUAL BLOCKAGE because the parameters and the effect on both are identical (Johnson's "equally strong, nasty, and determined force centers" (1987, p. 46). Thus, in MUTUAL BLOCKAGE of Johnson's type, rather rare in our everyday experience, the two opposite, force exerting objects have the same sets of Thematic roles. I suppose that in other force variations, with two 'unequal' forces at play, we can also reasonably expect the same sets of roles: Cause and Affected Entity. However, what would make the difference in the description of different force variations is the human perspective.

Consider, for instance, Johnson's example of a crawling baby encountering a wall which would block the baby's further progress. According to the scientific description of force, both the baby and the wall should have the same set of Thematic roles. However, I suspect that we would not normally regard the baby as Cause of blocking the wall, nor consider the wall as Affected Entity. I think we would rather reason that the baby unintentionally exerted force on the wall, the Cause of BLOCKAGE, and the baby would be perceived as Affected Entity, with a possible bump on the forehead. Naturally, the different perspectives would be expressed as relations encoded in respective verbs (Langacker, 1987, p. 344), blocking vs bumping into, hitting, etc.

I will divide FORCE image schema variations into three categories: contact forces, non-contact forces, and complex forces, in the following order:

    a) contact forces: BLOCKAGE, APPLIED FORCE[19] (see point 5.2.2.),
        DIVERSION, REMOVAL, PRESSURE, and FRICTION;[20]
    b) non-contact forces: ATTRACTION AND REPULSION;
    c) complex forces: ENABLEMENT and COMPULSION.

5.2. Contact forces

5.2.1. BLOCKAGE was defined by Johnson as encountering "obstacles that block or resist our forces" (1987, p. 45). He further wrote that "[…] a force vector [encounters] a barrier and then [takes] any number of possible directions" (1987: 45). I think that Johnson's second part of this statement on the force vector which, when blocked, takes "any number of possible directions" is misconceived. The only thing that BLOCKAGE means is that a moving object is blocked and stopped from further motion in the same direction. Any other remarks on the possible directions the force vector might take, are just speculations on DIVERSION, based on human perception. The diagram below is a modified version of Johnson's BLOCKAGE.[21]
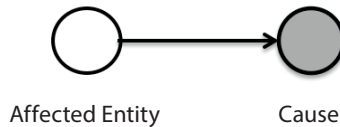

Affected Entity   Cause

Figure 2. BLOCKAGE image schema

As I mentioned earlier, COUNTERFORCE is described by Johnson as "head-on meeting of forces" (1987, p. 46). On the example of football players, Johnson explains that "[h]ere two equally strong, nasty, and determined force centers collide face-to-face, with the result that neither can go anywhere" (ibid.). He used the following diagram to represent the situation.

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[19] (https://www.physicsclassroom.com/class/newtlaws/Lesson-2/Types-of-Forces).
[20] APPLIED FORCE, PRESSURE, and FRICTION are new in comparison with the traditionally proposed sets.
[21] A circle represents an OBJECT schema; a grey circle symbolizes the focal element from human perspective.

$$F_1 \longrightarrow \blacktriangleright\blacktriangleleft \longrightarrow F_2$$

Figure 3. Johnson's COUNTERFORCE diagram

Johnson represents COUNTERFORCE only by two opposed arrows of the same length, meeting at some point, and marked F1 and F2. Force exerting objects are absent. It is clear that, nasty or not, the 'force centers' are simply physical objects, here football players, both Causes (Agents) and Affected Entities. One might concluded that if 'neither can go anywhere', the result is MUTUAL BLOCKAGE. However, MUTUAL BLOCKAGE does not exclude movement of the colliding objects. Compare, for example, fighting stags moving back and forth, with their antlers locked. Should one insist on a diagram of MUTUAL BLOCKAGE (Johnson's COUNTERFORCE), taking into consideration my definition of the image schema, it would take the form of the following diagram, showing the colliding, equally strong and nasty "force centers", the force exerting objects blocking each other.

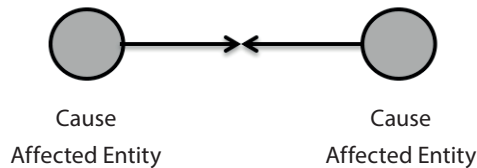| Cause	Cause
Affected Entity	Affected Entity

Figure 4. MUTUAL BLOCKAGE image schema

5.2.2. APPLIED FORCE is not commonly mentioned in literature, though it is one of the most frequent force variations that animate objects experience. First, the blocked object must have applied force on the blocking object. APPLIED FORCE is defined as "a force that is applied to an object by a person or another object. If a person is pushing a desk across the room, then there is an applied force acting upon the object. The applied force is the force exerted on the desk by a person" (https://www.physicsclassroom.com/class/newt-laws/Lesson-2/Types-of-Forces).[22] The diagram is similar to that of BLOCKAGE except with reversed Thematic roles and perspective. The focal element is also the Cause, and the arrow indicates the direction of its action.

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[22] *The baby bumped into the wall* is another good example of this variation.

Figure 5. APPLIED FORCE image schema

5.2.3. DIVERSION is explained by Johnson as a "variation on the previous gestalt [BLOCKAGE] in which a force vector is diverted as a result of the causal interaction of two or more vectors" (1987, p. 46) at some oblique angle. As I argued above, BLOCKAGE means simply stoppage of movement, and diversion is only a conjecture based on our experience. And it is not only "some oblique angle" at which the force exerting object is diverted by Cause, but even a perpendicular collision may 'divert' ('revert') the moving object back by 180^0. Thus, it is the force exerting object that is diverted and it is the focal element ("X diverted on contact with Y"). There is no need to add that the diagram below represents only two out of many possible configurations of the two objects in the diversion relation. Diversion would vary depending on whether the two objects were in motion in opposite directions, or the same direction on a collision course, and on the velocity and mass of both. It must be added that in many cases the force of the diverted object (Affected Entity) would also trigger diversion of the diverting object (Cause) in which case the structure of the schema would be different, both objects could be regarded as Causes and Affected Entities.
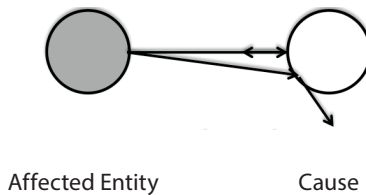

Figure 6. DIVERSION image schema

5.2.4. REMOVAL[23] is, according to Johnson, a "schema [...] that suggests an open way or path, which makes possible an exertion of force" (1987, p. 46). He further wrote that "the diagram is meant to suggest that, either because some actual barrier is removed by another or because a potential barrier is not actually present, the force F_1 can be exerted (i.e., there is nothing blocking it)" (1987, p. 46).

Johnson's interpretations contradict each other, and are incompatible with his diagram which clearly presents the very action of removal of a restraint. If "some actual barrier is removed by another [object?] or because a potential barrier is not actually present", then, there is no barrier to remove. Moreover, Johnson's words of "an open way or path" mean that the schema should contain no barrier to remove ("there is nothing blocking it"), and could not be labelled "removal of restraint". Johnson's diagram shows the actual barrier removal in action, not the "open way or path".
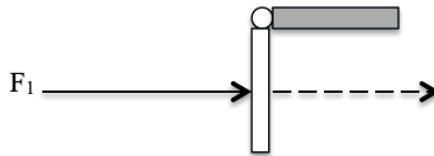

Figure 7. Johnson's REMOVAL OF RESTRAINT

Additionally, Johnson's diagram suggests that F_1 will continue its course. I submit that in reality, when the force exerting object removes a barrier, as a result of the contact with the latter, i.e., the opposite force, F_1 will rather divert than follow its earlier course. In any case, the further path of F_1 is not part of the REMOVAL image schema. The focus here is on Affected Entity. What is important is the barrier, not what caused its removal. The diagram below illustrates the situation.

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[23] I decided to use the label REMOVAL only, because 'restraint' is implied in the 'removal'. What else would we want to remove than a restraint, an obstacle, for physical, aesthetic, moral, or other reasons.
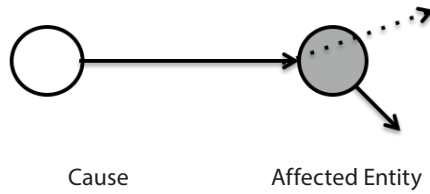
Figure 8. REMOVAL image schema

5.2.5. PRESSURE is an omnipresent force. The simplest example of pressure is the mere fact of one object resting upon another. OED defines it simply as "[t]he action or fact of pressing; the fact or condition of being pressed; the exertion of continuous force upon or against an object by something in contact with it; compression". The pressing object is the Cause, for example, a finger on a doorbell, or a lamp on a desk. The diagram below illustrates a possible configuration.[24]
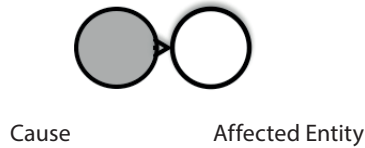

Figure 9. PRESSURE image schema

5.2.6. FRICTION, an omnipresent force in almost every aspect of our everyday life, has not been given attention as an image schema. For example, we can walk safely due to friction, our clothes rub against our skin all the time, water rubs against banks of rivers, moving air rubs against surfaces of objects, etc. Definitions of friction emphasize contact, motion, and resistance as elemental features. OED defines friction as occurring "[w]hen surfaces in contact move relative to each other", and as "[t]he resistance which one body meets with moving over another body". Merriam Webster Dictionary echoes these descriptions writing that "[f]riction is the force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other". From the point of view of functions of the two objects exerting

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[24] The arrowhead indicates the contact of the two objects, and at the same time the direction of the force.

force the situation is quite complex. It seems that independent of whether only one or both are in motion, both are Causes and Affected Entities. For example, when we walk on the floor, both surfaces (floor and soles) are at work and affected though perhaps from the human perspective, the floor would not be regarded as Cause. FRICTION can be represented schematically as in the following diagram.
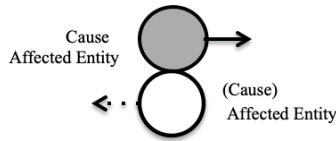
Cause
Affected Entity

(Cause)
Affected Entity

Figure 10. FRICTION image schema

5.3. Non-contact forces

5.3.1. ATTRACTION is explained by Johnson in the following words: "A magnet draws a piece of steel toward itself, a vacuum cleaner pulls dirt into itself, and the earth pulls us back down when we jump" (1987, p. 47). He represents the force with the following diagram:
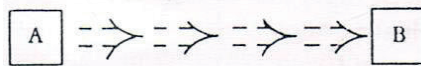
A ⇒⇒ ⇒ ⇒⇒ ⇒ B

Figure 11. Johnson's (Fig. 12.) ATTRACTION image schema

When we remember that physicists treat suction (vacuum cleaner) as a separate force (see, point 5.1.), what remains is gravitation and magnetic force. This is probably why Peña (1999) supported her discussion using metaphorical expressions: "We are attracted to good or beneficial forces or emotions such as happiness or love and try to get rid of or to be far from harmful emotions such as sadness, hatred or fear, so that they cannot control us because the further the subject is from the harmful force, the less control such a force has over the subject" (1999, p. 202). She makes the metaphorical nature of ATTRACTION (and REPULSION) clear by writing that "if any force (either in the form of an emotion or of any other abstract entity is personified, and thus, endowed with will-power, it may be able to cause pas-

sive subject or entity to move and to exert control over such a subject or entity" (1999, p. 203). However, through external observation, we might propose that a typical magnetic configuration is that one object is the attracting entity, and thus Cause, and the other is the attracted entity in Affected Entity role. Naturally, other configurations are possible, for example, when the magnet itself, if small enough (freezer magnets), will move and end up on the surface of the other, non-magnetized metal object. We would probably perceive this situation so that the freezer would be the attracting object (Cause), and the magnet would be the attracted entity (Affected Entity). The diagram below represents what can be considered a typical configuration.
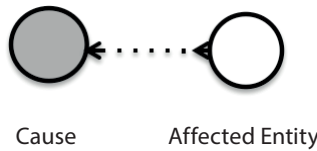

Cause   Affected Entity

Figure 12. ATTRACTION image schema

5.3.2. REPULSION is the other non contact-force, considered by Peña as opposite to ATTRACTION, and is also discussed by her in terms of harmful emotions that we try to get rid of (1999, p. 201). OED defines this force very briefly as "[t]he action of an object repelling another by some physical force, typically by the action of an electric or magnetic field; the tendency of two objects to increase their separation. […] Opposed to ATTRACTION". The diagram below depicts a configuration when the Cause (causing object) is stationary and repels another object, Affected Entity.
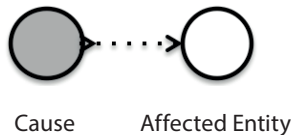

Cause   Affected Entity

Figure 13. REPULSION image schema

It is obvious, however, that, as in ATTRACTION, other configurations are possible, for example, when both objects repel each other ("increase their separation") at the same time. In conclusion, we can say that both ATTRAC-

TION and REPULSION are limited to electric and magnetic phenomena, and though objectively very important (including gravitation), have little significance in human cognition, except when used metaphorically.

5.4. Complex image schemas

5.4.1. Opening remarks

Before a brief mention of ENABLEMENT and COMPULSION, it is necessary to emphasize that according to Quirk et al., the verbs 'enable' and 'compel', representing the two schemas respectively, belong to the same syntactic type: "[C4] Object + to-infinitive complementation" (1985, p. 1203). The difference is that while the verb 'enable' is in common use, most examples of the verb 'compel' in OED are in an overwhelming majority quite old – the latest two examples, in absolute structures, come from 1903 and 1904. Dr Kearns explained (e-mail communication) that the active form of 'compel' "in the physical sense is dated, and the verb is used now in an emotional sense". It is necessary to add that both verbs have the same complex structure of result (Quirk et al., 1985, p. 1070):

- for 'enable': *X did smth to Y so that Y was able to-V*;
- for 'compel': *X did smth to Y so that Y had to-V*.
  Both phrases – 'to be able to' and 'to have to' are semi auxiliaries.

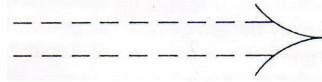5.4.2. ENABLEMENT is represented by Johnson as a double, broken line arrow (1987, p. 47; Fig. 11).

Figure 14. Johnson's (Fig. 11) ENABLEMENT schema

The diagram looks very simple, but it is not in concord with Johnson's interpretation of the schema, nor the definition proposed in my 2019b paper. As I pointed out, Johnson distinguished two elements of ENABLEMENT, "a potential force vector, and the absence of barriers or blocking counterforces" (1987, p. 47) which we feel as the "power (or lack of power) to perform some action, for example, the power to pick up the baby" (ibid.). In his description, the object that feels "the power to perform some action" is 'we'

(animate object, physical), and the object which the power would be applied to is 'the baby'.[25]

The absence of "barriers" makes the absence irrelevant, because an absence of barrier indicates ability only, while enablement implies prior removal of the barrier. It is significant that in his example "you feel able to move a chair", Johnson himself uses the semi auxiliary 'to be able to', not 'to enable'.

Johnson's interpretation was critically discussed by Peña (1999), Oakley (2007), and Szwedek (2019b). Peña observed that ENABLEMENT is only a logical entailment of REMOVAL OF RESTRAINT, rather than an independent schema (1999, p. 198). Oakley shared Peña's opinion questioning the bona fide image schematic status of ENABLEMENT (2007, p. 222). I analyzed a BNC example *The surgery on his knees enabled him to walk again*, and concluded that the RESTRAINT is implied, while REMOVAL OF RESTRAINT and 'ability' form a complex relation (resultative subordination) encoded in one lexeme (2019a, p. 8).[26] However, nowhere in the relevant literature did I find the idea that 'ability' is an image schema. Johnson only remarked that "it is legitimate to include this structure of possibility in our gestalts of force" (1987, p. 47), but did not provide any reason for such an assertion, nor did he offer any graphic representation of a structure of 'ability'. All these arguments are clear evidence against treating ENABLEMENT as a bona fide image schema.

5.4.3. COMPULSION is described by Johnson as "the experience of being moved by external forces, such as wind, water, physical objects, and other people" (1987, p. 45). His diagram is repeated for convenience.[27]

Figure 15. Johnson's COMPULSION image schema (1987, p. 45)

Johnson's description of COMPULSION schema poses certain problems. One is a minor point, but his list of the "external forces" is incoherent be-

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[25] At best, Johnson's arrow can only represent direction of movement.
[26] *The surgery/surgeon removed a restraint in his knee, in result of which he was able to walk again.*
[27] I think it could just as well depict REMOVAL schema.

cause it excludes wind (moving air), water, and people from the category of physical objects (cf. Szwedek, 2000b; 2011; 2018).

Another point concerns Johnson's words that "the force comes from somewhere, has a given magnitude, moves along a path, and has a direction" (1987, p. 45). Apart form the obvious attributes of 'magnitude', 'path', and 'direction' of every force, somewhat surprising is the phrase that "the force comes from somewhere". All forces 'come from somewhere', but as I emphasized in my 2019b paper, the direct cause of force impact is always a collision of physical objects. Thus, in the complex structure of compulsion (cf. point 5.4.1.), it is not the causing force 'coming from somewhere' that is in focus, but the compelling manner of movement of the affected object – it is the 'compulsive vector' that is actual (broken arrow), not the potential one (solid arrow).

Finally, Johnson's use of the term 'experience' is rather unfortunate. According to OED, the essence of 'experience' is consciousness' and 'knowledge'.[28] Thus, it is an attribute of human (animate?) objects only. Apart from the fact that the active form of 'compel' "in the physical sense is dated, and the verb is used now in emotional sense (Dr Kearns: e-mail communication), what kind of 'compulsive' experience could leaves have when compulsively moved by wind? All these arguments make COMPULSION questionable as a *bona fide* force image schema.

6. Conclusions

The present paper is a critical discussion of FORCE image schema variations known from the cognitive literature. I have proposed to divide the variations into three types:

a. contact force schemas: BLOCKAGE, APPLIED FORCE, DIVERSION, REMOVAL, FRICTION, PRESSURE;
b. non-contact force schemas: ATTRACTION and REPULSION;
c. complex schemas (Szwedek, 2019a): ENABLEMENT and COMPUL-SION.

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[28] "The fact of being consciously the subject of a state or condition, or of being consciously affected by an event", and "[k]nowledge resulting from actual observation or from what one has undergone".

I have suggested that complex image schemas whose schematic status was questioned by Peña (1999), Oakley (2007), and Szwedek (2019a), do not conform to the adopted framework, since they are complex structures.

The paper has shown that all FORCE configurations are variations of COUNTERFORCE, which is in consonance with Newton's Third Law of Motion, aptly elucidated by Resnick, Halliday, and Krane in the following words: "there is no such thing as a force that is not accompanied by an equal and opposite force" (1992, p. 83). In the light of my definition of the image schema (2019b), it means that any type of force is a structure of two force exerting objects and a relation (force exertion) between them. Resnick, Halliday, and Krane further explicated that "[i]n some situations, the magnitude and direction of the forces are determined entirely by one of the bodies (1992, p. 83), and "[i]n other situations the magnitude and directions of the forces are determined jointly by both bodies" (1992, p. 83). But it is always a counteraction configuration of two bodies in contact.[29] The paper revealed the importance of human perspective in the interpretation of forces. Since force involves two bodies, it is natural that we perceive either one, or both, as salient. This will naturally determine the choice of lexical representation of the relations. For example, while BLOCKAGE could be represented by such verbs as block, stop, clog, plug, etc., APPLIED FORCE could be expressed by such verbs as push, bump into, hit, etc.

In most cases, as the diagrams show, focal elements are Causes (BLOCKAGE, APPLIED FORCE, PRESSURE, ATTRACTION, and REPULSION), but schemas like DIVERSION or FRICTION indicate that the situation is more complex, since, depending on the point of view, either one or the other, or both may be in focus (e.g., 'rub against each other').[30]

The paper has demonstrated that the force relations between two force exerting objects form highly complex configurations of mass, velocity, type of contact, and human perspective. The configurations are categorized by human beings into a limited number of types of simple image schemas. The

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[29] In this context, it is appropriate to remind the reader of my views on the role of touch in image schema formation in the prenatal period (see, a number of papers by Szwedek since his 2001 to 2023a).

[30] As I pointed out in my 2022 paper, among Causes, the most prominent role in human experience is Agent. This is corroborated by evidence from syntax. Commenting on the Subject in English, Berk observed that „[t]he agent subject is the classical doer of the action. […] Most speakers consider the agent the most typical subject. If you ask someone to construct a sentence out of thin air, it is likely that s/he will utter one with an agent subject (1999, p. 15).

examples discussed above are the most often discussed in the literature, but they do not exhaust the subject. Physicists identify many more forces, such as "suction, tension, stress, elastic forces, torques, centripetal forces, and others" (Duch: e-mail communication, Oct. 2021) that still need exploration. Thus, I want to conclude the paper with a perennial appeal for further research.

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