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# How metaphor and narrative interact in stories of forces of nature

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# Introduction

Through its formalisms, science, especially physical science, presents us with a curious form of thought that is supposed to be reflected in science education even for the very young. An uncritical scientism would have us believe that the pronouncements of science are to be taken literally, and that there is an exclusive form of practice that must be observed if what we do is not to be considered unscientific.

In contrast, we take the view that knowledge of the world is not a one-on-one relation between our words (and equations) and the world (Fuchs, 2006). Rather, an embodied human mind intervenes in a way that makes thought and understanding – and with them, words and equations – a largely imaginative and figurative affair, and therefore more easily accessible, at least to a certain degree and in certain forms (Fuchs, 2015; Amin, 2009; Amin et al., 2015).

This last statement sketches our point of departure. As educators, philosophers, and cognitive scientists, we are interested in the question of how humans encounter and understand nature and, in due course, science. We have investigated the conceptual nature of macroscopic physical science from the perspective of an embodied mind and found that it presents us with metaphoric and narrative structures. This has encouraged us to design *stories* of *forces of nature* – such as wind, water, ice, fire, food, or electricity – first, as analytic tools in the education of primary school teachers, and secondly, as stories to be used for small children in class.

In this chapter, we shall present an example of a story and its use, point out the metaphors it contains, and argue that its conceptual structure is the same as that of its formal counterparts in physics. In other words, we claim that all of us can learn some good physics from stories of forces of nature.

Moreover, we use the opportunity to contribute to the theme of metaphor and narrative by tackling the question of how the two interact in such stories. We find that, in general, analysts of metaphor or narrative treat one or the other of these cognitive tools but not both at once. Narrative is not commonly a theme in conceptual metaphor theory, and metaphors are not the main concern for the narratologist.

We shall discuss three perspectives regarding the question of how metaphor and narrative relate to each other. First, and this may be the most directly useful for education, stories of forces of nature lead us back to what Kieran Egan has called mythic culture and mythic understanding (Egan, 1988, 1997). The interaction of physical phenomena and a mythic mind presents us with an experience where metaphors and stories form a natural unity~~.~~

Secondly, we describe how the question of the relation between metaphor and narrative has been taken up in in modern philosophy and cognitive science.Finally, we briefly sketch a model of perception at different scales that shows us how, in stories of forces of nature, metaphors give (formal) content to stories and a story informs us about the meaning of the metaphors it contains.

However, before we turn to a concrete example of a story and the body of this chapter, we shall very briefly outline our use of some important basic terms – *experience*, *perceptual unit* or *gestalt*, *scale*, and *force*.

# Experience, gestalt, force, and scale

***Experience***. In some simple models of cognition, *conception* is often assumed to follow *perception* where perception is the input to an individual mind of information from the environment. However, we assume that conception – particularly as made apparent in the form of natural language production and reception – feeds back upon perception in creating an *experience*.

We use the term *experience* in Dewey’s (1925) sense as the result of *feedback* in *action-perception loops*, occurring between an organism and its physical, social, psychological, and cultural-linguistic environments. Alternatively, we might call experience the *unified action of perception and conception*. We are concerned with mainly two forms of experience and their interaction: *Physical* and *linguistic*.

***Perceptual units or gestalts***. In cognitive science, it is quite common to assume that perception, or more generally, experience, is holistic in some sense. Perception does not present us with an endless unordered stream of sensations but creates units called shapes or gestalts (Arnheim, 1969). Cognitive linguists use this idea to describe certain basic results of experience (such as *balance*, *scale*, *verticality*, *container*, or *path* schemas; see Johnson, 1987) as perceptual gestalts that are called *image schemas*. We argue that what we call *forces of nature* are perceptual units as well. The notion of *gestalt* might become clearer if we consider some examples right here.

***The notion of* force *and forces of nature***. When we observe how ice and water have shaped our natural environments over thousands and millions of years, or how fire, water, and wind still do this every day, we call water, wind, fire, and ice *forces of nature*. We also call people or social institutions forces, and we are aware of emotions as forces that cause feelings that drive us to actions. In all cases, it is clear what we perceive – we know when we have an experience of heat, or justice, or anguish. This lets us formulate the assumption that forces are *perceptual units* (perceptual gestalts; see Fuchs, 2006, 2011).

Put more generally, force denotes any *dynamical phenomenon presenting itself as agentive to the human mind*. Examples are love, music, justice, pain, light, food, wind, water, ice, electricity, etc. In other words, the mind perceives a unit that lets us easily recognize what kind of force we are dealing with. Clearly, we experience social, cultural, psychological, and natural forces.

***Temporal, spatial, and systemic scales (of experience)***. Unaided by instruments, perception and conception happen in a limited range of temporal, spatial, and systemic scales. Time scales range from seconds to maybe years, and spatial scales from fractions of a millimetre to some hundreds of kilometres. Here the term *scale* is unproblematic. It is more difficult to describe what is meant by systemic scale. We could speak of structural scale – how simple or complex a physical or social structure appears to be – but that would leave out the aspect of dynamic complexity. That is why we have chosen the term systemic scale, to denote the degree of both structural and dynamic complexity.

Interestingly, if we admit *stories* as “instruments,” the scale of unaided experience is wider than it would otherwise be. Storytelling allows us to come to terms with time scales longer than a single human life, spatial scales larger than what a single human can travel in a lifetime, and systemic scales larger than what a single mind can fathom.

It seems fair to say that our encounters with nature happen essentially at the human scale of experience that is reflected in continuum physics and its applications to chemistry, biology, natural science, and engineering (Fuchs, 2010 [1996]). Our analysis will be restricted to this area of modern science and technology.

# Stories of forces of nature: Physical science as myth

We now turn to a description and investigation of a particular area of experience and how it is shaped by the unified action of perception and conception – namely, physical phenomena at a human scale, our interaction with these phenomena, and how our perceiving them leads to scientific conceptualization. Of the kinds of macroscopic physical phenomena accessible to our senses, we shall choose what are commonly called *heat* or *cold*.

We shall argue here that we can create and make good use of stories of forces of nature that have a mythic quality and yet are scientific in the sense that they build on the same basic notions used in understanding nature that are found in formal renderings of physical science. In the course of this argument, we shall present an example of a story; demonstrate some of the metaphors it uses and how these metaphors structure a larger-scale perceptual unit, namely, *force of nature*; and outline the mythic quality of such stories that makes them particularly suited for young children while at the same time being perfect repositories of knowledge that is part of physical science.

***An example of a story of forces of nature***. In order to lay the ground for where and in what form metaphors and narratives can occur in the field of science education, we now present a short section from a story of *cold as a force of nature*. (We shall discuss the concept of force of nature further below in more detail.) The excerpt is from the *Winter Story* (Fuchs, 2011, 2013a; Fuchs R., 2010-2014) that was written to facilitate the study of narrative in physical science and has been used in teacher training and in various forms for children at primary schools in the Modena region (Corni, 2013; Corni et al., 2015):

As the last of the warmth of late Fall left the plain surrounding Little Hollow, cold found its way into the area and spread out. Because the plain was so wide, the cold of winter had to spread pretty thinly, so it was not all that cold up there. Moreover, even in the midst of winter, the Sun managed to send some warming rays onto the plain.

[…] But in Little Hollow, things were different. The cold of winter knew a good place where it could do its job much more easily of making everything and everybody cold. It could flow into the hollow where the town had been built. It could collect there and it knew it would not be driven out so easily by a little bit of wind as could happen on the plain. […] More and more cold could collect in Little Hollow, and it got colder and colder as the winter grew stronger. The temperature fell and fell.

The people of Little Hollow […] knew that [the] cold could even sneak in through tiny cracks between walls and windows, so [they] had learned to build their homes well and put in strong wood burning stoves.

[They] made sure that fires roared in the stoves [to] balance the cold. But it was an almost impossible fight: The cold loved to go to where it was warmer and it would eventually get what it wanted. […]

When there was less cold and the temperature was a little higher, the snow became warmer and much more fun to play with. When that happened the cold of winter knew its time had come. The warmth of early Spring would grow stronger and drive the cold out of the hollow. The cold knew it had to accept its defeat but it also knew very well it would be back…[…]

***Metaphors and forces of nature***. Let us now perform a bottom-up approach to an analysis of this story and look at figurative elements contained in it. This means we do not look at the story as a unit or whole at this point. Some examples of metaphoric expressions and suggested conceptual metaphors are listed in Table 1.

We can find a large number of concrete metaphoric expressions hinting at metaphoric projections of simple schemas in the *Winter Story*. Take as an example the expression *The cold loved to go where it was warmer*, which makes use of several schemas. *Cold goes* indicates that it is an object in our mind; the word *go* hints at a path along which it moves; and *where it was warmer* uses the scale schema and suggests a tension created by the difference of how cold it is at the origin of the path compared to how warm it is at the destination. Formally or scientifically speaking, we would say that *cold flows from where it is cold to where it is warmer*.

A note on personification is in order here. What we see happening may be called a version of this process, but it is a special – we might say, quite natural – kind. We do not have to speak of “Father Frost” or the like. *Cold* immediately and easily forms a vivid figure of an *agent* in our mind. A force is *agentive*, and natural language provides us with means of referring to it in a way that has some semblance to personification.

Interestingly, all these schematic expressions can be grouped as we have done in Table 1. This grouping is not accidental; it hints at the existence of a larger-scale structure than that represented by, say, a basic metaphor.

The structure emerging here is that of *force of nature*. When analysed, the gestalt of force presents us with three main aspects – *intensity*, *quantity*, and *power*. These are each understood in terms of smaller webs of (figurative) relations involving additional schematic resources and their projections; examples of such resources are the *path* and *container* schemas and, quite generally, *force dynamic schemas* (Talmy, 2000). Witness the expression *…more and more cold could collect…*.

Table 1. *Metaphors and some expressions in the Winter Story*

|  |  |
| --- | --- |
| **Conceptual Metaphor** | **Linguistic Metaphoric Expression** |
| **COLD IS A (FLUID) (MOVING) SUBSTANCE/OBJECT** | The cold found its way into the area and spread out.  It could flow into the hollow… it could collect there…  The cold could even sneak in through tiny cracks between walls and windows… |
| **(THE DEGREE OF) COLD IS A THERMAL LANDSCAPE** | The cold loved to go where it was warmer…  And it got colder and colder as the winter grew stronger. The temperature fell and fell.  When it had become terribly cold and the temperature was very, very low… |
| **COLD IS A POWERFUL AGENT (MOVING FORCE)** | The cold of winter knew a good place where it could do its job of making everything and everybody cold…  The fires in the furnaces had to work very hard to fight the cold.  Spring would grow stronger and drive the cold out of the hollow. |

Note that the imaginative processes sketched here are of a particular type – small-scale schematic elements and their projections create a medium-scale conceptual structure that can be described by a number of conceptual metaphors. At this point, it appears that all we need to understand macroscopic physical phenomena is a bottom-up process of combining larger units from smaller ones. A still larger unit – narrative – seems to be unnecessary for improving upon our understanding. This appearance is mistaken, however.

***Mythic quality of stories of forces of nature***. There is a more general holistic approach to the study of the *Winter Story*. Looking at the story from a mythic viewpoint helps us toward a unifying approach (Egan, 1986, 1988).

The *Winter Story* has a structure that makes it approachable to a mythic mind. We recognize cognitive tools of that stage: binary opposites (*polarities*), metaphors, and the overall story structure (Egan, 1986, 1997). Our story emerges from the tension inherent in the *hot* ↔︎ *cold* polarity and brings the *character of cold* to life (Fuchs, 2013a,b). As Wayne Neely puts it in his book *The great Bahamian hurricanes of 1926*: “A myth is […] a traditional story, typically involving supernatural beings or forces or creatures […]” (Neely, 2009, p.2). Considered as an example of myth, the *Winter story* suggests that, by revolving around the character of *cold*, there is a unity between the story and the metaphors it contains. We shall reconsider this statement from two different perspectives in the following sections.

***Using stories of forces of nature in education***. As mentioned above, we have created such stories for cognitive research and in educational settings. We shall briefly outline here how the stories have been used in education.

First, stories such as the *Winter story* are used to present student teachers at kindergarten and primary school levels (at the Universities of Modena and Reggio Emilia, Verona, and Bolzano) with examples that are meant to demonstrate how a concrete form of primary science education can be designed for children at kindergarten and primary school (Corni et al., 2017; Corni & Fuchs, 2018). Students learn to analyse such examples and recognize imaginative structures, and they are asked to write their own stories. At the same time, they learn some formal physical science of macroscopic processes that is meant to alert them to the same basic form of conceptualization as the one found in accounts of forces of nature using natural language (Fuchs, 2010, 2013c, 2015). Our goal is to help student teachers to become confident narrators of stories of forces of nature.

The *Winter story* is employed as well for in-service teacher training and their pupils in primary schools (Corni et al., 2015). Its reading is accompanied by a series of activities engaging various forms of expression (mimetic, verbal, visual) to help children grasp the behaviour of cold, such as discussion of personal experience, dramatization of the plot of the story, experience of heating of water by immersion of hot stones and drawing of pictures of the experience in temporal sequence, including discussion of what happened during the process.

# When metaphor and narrative interact

We will start with an observation based upon recent studies dedicated to metaphor and narrative, respectively, where some important parallels can be noticed (Contini, 2015). Over the past few decades, philosophers, psychologists, anthropologists, linguists, and scholars in the field of education have offered insights into the fundamental role of both narrative and metaphor. Still, metaphor and narrative have mostly been utilized separately (Hanne, 2011).

It is worth emphasizing the growing number of reasons for connecting these two realms, especially if the aim is to study the role played by metaphor and narrative within the fields of science education and communication. Two projects appear noteworthy here. First, the pioneering project undertaken by Michael Hanne since the 1990s (*Narrative Metaphor Nexus*) that explores how narrative and metaphor function in four major disciplines, namely, medicine, politics, law, and education (Hanne, 1999; Hanne, 2011; Hanne, Crano & Mio, 2015; Hanne & Weisberg, 2018). Second, the *Center for* *Metaphor and Narrative in Science* at the University of Modena and Reggio Emilia that aims to promote multi- and inter-disciplinary research relating to the role of metaphor and narrative in science communication, science education, and mathematics (see www.manis.unimore.it).

***Metaphor and narrative in cognitive science***. It is no longer only academics of aesthetics and literature who are interested in metaphor and in narrative but also scholars working in disciplines that can be grouped under the umbrella of *cognitive sciences*. An interdisciplinary approach to metaphor and narrative analysis can help tackle problems – such as the relation between literal and metaphorical meanings; or why narrative is something we need to make sense of the world – where previously it had seemed difficult to find solutions when metaphors and stories were studied in an over-compartmentalized way (Steen et al., 2010; Herman, 2013; see also Ortony, 1979/1993; Gibbs, 2008; Hogan, 2013).

***Metaphor and narrative as tools for reasoning***. Metaphor is no longer considered a mere rhetorical ornament added to literal language, nor a strictly linguistic entity; narrative is no longer considered just a literary genre nor is it considered simply a sequentially organized representation of events.

New approaches to metaphor theory are based upon the argument that metaphor use and understanding involve reasoning and inferential and conceptual processes. In particular, metaphor involves both the application of previously acquired categories and conceptual schemas, and the creation of original categories and conceptual schemas (Lakoff & Johnson, 1980; Glucksberg, 2001; Steen, 2015).

The new wave in narrative theory equally focuses on the cognitive basis for creating and understanding stories. Therefore, in order to generate or comprehend even the most minimal stories, complex cognitive operations such as making scripts and frames interact are performed: For example, Emmott (1997) and Margolin (2003) hypothesize that scripts and frames guide readers’ interpretations of particular situations, participants and events, and that in turn the text can force readers to modify the interpretative models on which they have hitherto relied.

Above all, scholars have studied narrative itself as an instrument for sense-making, for the exercise of cognitive abilities, that is to say, as a basic resource for intelligent activity across a variety of settings (Bruner, 1986). In short, both metaphors and stories can be viewed as tools for thinking (Herman, 2013; Kövecses, 2015).

***Metaphor and narrative as relational constructs***. Both the new metaphor theory and the new narrative theory underscore the necessity of considering metaphor and narrative, respectively, as relational constructs. According to the seminal work by Max Black (1962, 1979), metaphors of the form “An A is a B” act by projecting onto the primary subject (the A concept) a set of associated implications included in the system that is linked to the secondary term (the B concept). Black’s notion that metaphor operates via an inter-domain connection is one of the crucial assumptions of psycholinguistic approaches to metaphor, from Lakoff & Johnson’s theory (1980) to the most recent studies on the subject, where the difference between novel and conventional, and *deliberate* and *non-deliberate* metaphors is particularly stressed (Steen, 2015; Prandi, 2017).

Likewise, according to the new narrative theory, stories enable tellers and interpreters to establish spatiotemporal links between regions of experience and between objects contained in those regions, and to impute causal relations between events. Narrative comprehension also requires situating participants within networks of beliefs, desires and intentions.

***Bridges and roads***. Our hypothesis is that metaphor is, as Vico (1744/2001, p.587) claims, “a little fairy tale,” while narrative is a sort of continuous metaphor. If, as Beck (1987) pointed out, “metaphors force the mind to construct a high-order linkage between the entities referred to” (p. 13), if metaphors “are like bridges” (Cortazzi & Jin, 1999), then the stories are like a network of links. It is significant that in Italian the narrative structure chosen by the author when creating a text is called *trama* which usually translates as *plot* in English. However, in Italian the meaning of *trama* is twofold, one is literary whereas the other refers to the complex weave of hundreds of threads in cloth.

***Narrative integration***. Narrative organizes image schemas, metaphoric projections, and conceptual and linguistic metaphors in terms of a network representing a sort of connective fabric. For this reason, *the cognitive power of one metaphor depends on the way it is interconnected with the others and in how the thread is interwoven in the plot of the narrative*.

Let us consider the famous Proustian image of the *petite madeleine*, the biscuit dipped in tea, which unexpectedly brings back the whole experience of Combray. The “resurrection” of Combray is achieved through a series of metaphors: The reminiscence “beats” deep down in the Narrator, to slowly emerge and be mixed with the “insaisissable tourbillon des couleurs remuées” (Proust 1913/1987, p. 46). Now, not only is the meaning of each of these metaphors illuminated by the meaning of the others, but all these metaphors are fully comprehensible only in the light of the whole tale of the Proustian *Recherche du temps perdu*. In fact, we could link these metaphorical expressions to a conceptual metaphor of the type The most authentic reminiscence lies in the depths of the memory, but even this conceptual metaphor implies opposition between voluntary and involuntary memory, an opposition which the reader begins to understand only when comparing the first narration of Combray with the second.

So, we must ask ourselves, how does this process of integration take place? And how does the narrative characterization of forces, causes, agents, and processes occur?

In order to provide an answer, narratology stresses the existence of a grammar of stories. According to this model (Stein & Glenn, 1979), even the simplest narrative involves two moments: The *Setting* (the physical, social, or temporal environment in which the remainder of the story occurs) and the *Episode*. More recently, Herman (2013) has defined the story as the prototypical member of the category of narrative, and has argued that stories are narratives that include all of the following elements: 1) *Events*; 2) conscious *experiencing of events* by *agents*; 3) *tension to create events*; 4) *occasion for telling* by a narrator. According to Herman, the analysis of making sense of stories should be coupled with the analysis of stories as sense making. People use narrative as a problem-solving strategy in many contexts: for example, problems are solved by retrieving similar past experiences in the form of stories and applying the lessons learned from those stories to the new problems. Narrative functions are a powerful, basic tool for thinking and reacting, a primary resource for building and updating models for understanding the world.

***Summary***. We have called metaphors bridges. Let us extend this analogy and say that a story creates a scene of a town with the network of roads connecting a number of bridges that cross the river flowing through town. Without the town and roads the bridges still exist but their meaning or function will be utterly different.

# Metaphor and narrative as experiential structures at different scales

We now outline, very briefly, a model of experience at different scales, applied to stories of nature (Fuchs et al., 2016).

***Scales of experience***. Let us consider sources of perception/conception from a generalized perspective: *Perception takes place at different temporal, spatial, and systemic scales* (see Section 2). While we commonly appeal to notions of gestalt perception when talking about small-scale events, it is important to realize that the same process of forming perceptual units is at work when we are engaged in larger-scale perception.

At *small scales*, we form image schemas, i.e., structures of the embodied mind that result from recurrent sensory-motor interaction between an organism and its physical, emotional, and social environments (Johnson, 1987). We commonly use short utterances to express the content of conceptualization associated with small-scale schemas.

Forces are *medium-scale imaginative structures* that result from the direct experience of physical, emotional, and social agentive phenomena. They give a first hint of the notion of powerful agents. When we communicate about forces, one or a few sentences suffice to describe the type of event most directly associated with the perception of the action of a force. Such relatively short descriptions make use of medium-sized webs of metaphors.

Finally, *large-scale* imaginative structures resulting from large-scale experience that follow their own schemas are called narrative/story/myth. Narratives are the linguistic products that are used to recount and explain large-scale perception of events and actions and interactions of characters (agents) unfolding over (longer) time. Examples of story-like phenomena are a forest fire, the birth of a child, a hurricane hitting a tropical island, etc.

Analysing perception and (linguistic) conception in this manner suggests that conception is not a one-way bottom-up route; there are feedback loops between units and linguistic products at all scales.

***Heat or cold as powerful agents***. Stories are the ideal repository for an expanded understanding of the nature of forces. Whereas metaphoric processes are perfectly capable of delivering, for example, the notion of heat (or cold) as a fluid quantity, we get a rather stronger and expanded view of heat if we allow narrative perception to add to our conception.

We should remember what is cognitively unique about narrative – what conceptual structures does narrative create that are not already present in a metaphoric web created from small-scale perceptual stuff? We have seen that notions of *time*, *agency*, and *dynamics* properly belong to the narrative realm. When applied to a force, these schemas let the notion of a powerful agent and its “adventures” arise in the imagination: We arrive at a metaphor cold (or heat) is a powerful agent. Experience of larger scale phenomena (those which we relate to narrative) lets us see agents through the process of *narrative framing* (Fuchs, 2015).

How does this work? Interestingly, it does not directly change a metaphor of the type we have encountered in our analysis of the gestalt of heat. The metaphor cold is a fluid substance is not fundamentally changed – the logic it entails remains intact. Rather, it is as if the smaller-scale metaphoric conceptual structures of a force came together under the strong light of the narrative. Through cold (or heat) is a powerful agent, we can literally “see” a figure with its main aspects (intensity, quantity, and power) united – a story re-unites parts of the whole and makes the whole emerge prominently. A story provides synthetic rather than analytic understanding.

Expressed differently, a story does not reformulate its metaphors, it re-assembles existing webs and creates the largest possible web of figurative structures for its subject. If metaphors are bridges, a story creates the web of roads that connect the bridges in a town.

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Science and science learning do not proceed by simply stating some definitions of terms, and then assembling them into relations and the relations into theories after which we formally derive consequences of the theories. We understand nature, and science, in imaginative ways that make use of narrative and metaphoric structures. Science is a representation of our experience, i.e., of the unified action of perception and conception of nature in a much deeper way than mere formalisms make us believe. That is why stories of forces of nature are such powerful tools, especially for primary science education but also, in appropriate form, for formalized science education for mature learners.

Stories of forces of nature may very well be the siblings of typical stories children all over the world are exposed to. What we hope to achieve is that students see nature – and through it, science – in a new light. It is not any longer a world that is so totally different from the society of our fellow human beings. Nature is filled with agents with whom we can interact – communicate. We feel we are in a position to understand and predict the behaviour of these agents (folk physics) just as we wish to predict human behaviour (as in folk psychology; Hutto, 2007).

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