From Metaphors to Narratives in Macroscopic Physical Science: Stories of Forces of Nature for Young Children and their Teachers

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A Preliminary Summary in the Form of Some Claims

Macroscopic physical science exhibits ***imaginative structures*** *known from conceptual metaphor theory. They are* ***created by projecting small-scale image schemas*** *(polarity, scale, substance, container, path…)* ***upon the medium-scale perceptual gestalt of forces of nature*** *(water, wind, fire, ice, food, light, motion…).*

On the other hand, ***perception of a storm or a forest fire leads to large-scale imaginative structures that are commonly dealt with in narratives****. This lets us embed our* ***understanding of forces*** *in stories allowing for a* ***narrative approach to physical science*** *that can be made formal if needed.*

Children (and adults) ***learn about nature*** *at human scale through* ***narrative practice*** $\rightarrow$ ***NPH (Narrative Practice Hypothesis)*** *for Physics.*

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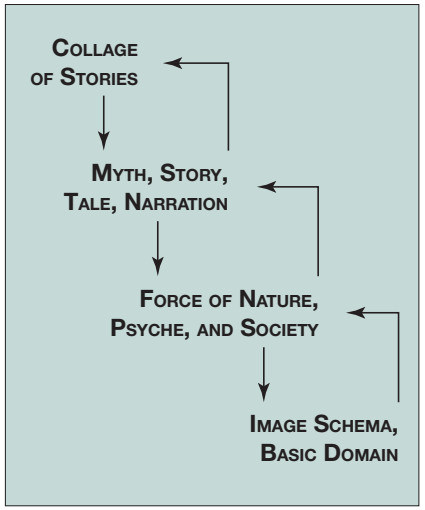


1. Linguistic Phenomena in Macroscopic Physical Science — Heat

Examples of expressions involving heat. There are ***no examples of literal use of language****:*

- All bodies ***contain heat***.…
- How do you ***collect heat*** in a passive solar house?
- This means ***heat flows*** "downhill" from hot to cold.
- … ***heat is an agent*** of vast importance in chemical reactions and engineering processes
- Law of the dependence of the active ***force of heat*** upon the tempera… (Clausius)
- This exterior ***heat lets*** the crust become crispy
- ***Heat makes*** me dizzy…
- Clouds and storms follow the warm water, ***pumping heat*** and moisture high into the atmosphere…
- Heat must ***balance*** cold…

Expressions for heat use the following ***schematic constructs****:*

- Container, store, hold, accumulate; lack of, abundance of; collect
- Flow, transport, extract emit/absorb, exchange; heat moves
- Balance (law of balance of…)
- Use, produce, generate heat
- Heat as location, landscape; level, intensity, degree, scale of heat
- Balance of heat and cold, hot and cold; thermal tension
- **Power, force of heat**
- **Heat is an agent: Heat causes, drives, makes, counteracts, lets, balances**
- **Heat is a patient: Pump, force, make, counteract, block, hold (back), enable, prevent, oppose, let/allow heat**

Heat is a powerful agent…

1. Linguistic Phenomena in Macroscopic Physical Science — A Story…

A Winter Story — a story built upon some good physics…

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. […] The cold of winter knew a good place where it could do its job 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 […] ***The people of Little Hollow […] knew that the cold would find its way into their homes if they were not careful to close windows and doors. The cold could even sneak in through tiny cracks between walls and windows, so the people had learned to build their homes well to make it hard for cold to flow in.*** […] At times when much cold had collected in their town the fires in the furnaces had to work very hard to fight the cold. The people in their homes made sure that the heat produced by the furnaces would always balance the cold so that their homes felt comfortably warm. (*R. Fuchs and H. Fuchs, 2010*)

2. Forces of Nature and Their Stories – Origin and Examples

In the previous examples, we recognize a recurring ***medium scale cognitive structure*** → ***Force of Nature***.

This structure has ***perceptual origin*** → the ***Gestalt of Force***.

Examples…

Heat as a force of nature

Very basically, we perceive HEAT as a unit/gestalt. We know when we have a thermal experience…

Examples of forces of nature

Water, wind, light, ***heat***, cold, food, motion, substances…

Psychological and social forces

Justice, ***music***, knowledge, anger, love…

Music as a force…

Mark Johnson analyzed our experience of ***music*** *in terms of three groups of metaphors:* MUSIC AS A MOVING OBJECT, MUSICAL LANDSCAPE, MUSIC AS MOVING FORCE.

← Johnson, 2007, Chapter 11

2. Forces of Nature and Their Stories – Metaphorical Structure of Cold

Conceptual Metaphor	Linguistic Metaphoric Expression
COLD IS A (FLUID) (MOVING) SUBSTANCE/OBJECT	*The 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,…* *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	*Winters in Little Hollow were harsh.* *So it was not all that cold up there.* *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…* *It went into the snow lying on the ground to make it very cold as well and this made the snow drier and harder to work with.* *It knew it would not be driven out so easily by a little bit of wind…* *The fires in the furnaces had to work very hard to fight the cold.*

2. Forces of Nature and Their Stories – Imaginative Structure

The perceptual gestalt of forces of nature

Direct perception of forces of nature

Wind, water, light, fire, ice, thunderstorm, food, soil, motion…

[Formal versions: *fluids, electricity and magnetism, heat, substances, linear motion, rotation, gravity.*]

→ **Macroscopic physics is a collection of theories of Forces of Nature**

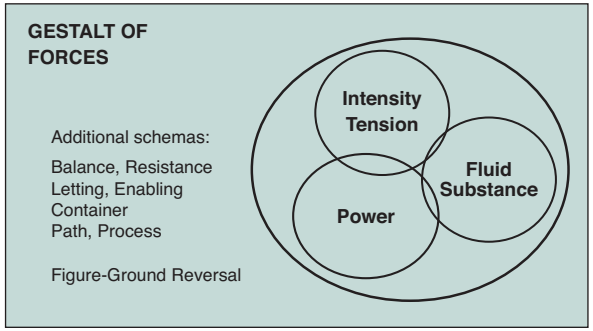
Examples of social and psychic forces

Justice, the market, love, pain, anger, music, evil, imagination…

Figurative structure of forces (basic aspects)

→

- **Intensity** (quality, derived from polarities; **tension** as differences of intensity)
- **Substance** (quantity)
- **Power** (as a measure of causation)



2. Forces of Nature and Their Stories — Toward Narrative

Examples of Stories of Nature

Birth of a child, a forest fire, hurricane Sandy, the creation of the world…

Forces and Narratives

When interacting with objects in the world and with other ***agents***, a ***force*** (of nature) creates an ***event*** that ***unfolds over time*** and ***changes*** things in the world → **Story**.

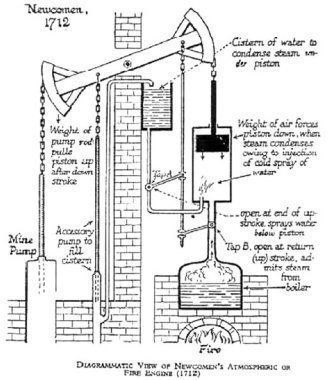
Narrative Framing

In stories, we can ***frame natural scenes*** where forces of nature live through adventures…

In other words, ***content*** and ***structure*** of scientific knowledge are ***integral components of stories***.

2. Forces of Nature and Their Stories — Metaphors and Narrative…

- Both the new metaphor theory and the new narrative theory underscore the necessity of considering both ***metaphor and narrative as relational constructs***.
- According to the seminal work of 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 are 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 ***cognitive approach to metaphor***, from Lakoff and Johnson's (1980) conceptual metaphor theory to some of the most important theories today (e.g. Fauconnier, Turner 2002; Kövecses 2015).
- Likewise, according to the new narrative theory, ***stories enable tellers and interpreters to establish spatio-temporal links and to imputing causal relations between events*** (Bruner 1986; Emmot 1997; Herman 2013).



Diagrammatic View of Newcomen's Atmospheric or Fire Engine (1712)

2. Forces of Nature and Their Stories — Metaphors and Narrative…

- Our hypothesis: metaphor is (like Vico claims) "a little fairy tale", while ***narrative is a sort of continuous metaphor***.
- If metaphors "are like bridges" (Beck 1987), the ***stories are like a network of bridges or like a network of links***.
- For this reason the cognitive power of a metaphor depends on the way it is interconnected with all the others, in the way the thread is interwoven in the plot of the narrative.
- ***Narrative organizes*** image schemas, metaphoric projections, conceptual and linguistic ***metaphors in terms of a network***. Narrative represent a sort of connective fabric.
- There is an important function that is performed in the ***narrative*** by the ***categories of time, agent, agency, process*** (see Ricœur 1983-1985), and the resulting continuity between stories and scientific forms of thought.

"… in a narrative, a metaphor is not only in context but also takes a meaning not reducible to what we might associate with it in isolation."

← Contini, 2015

3. Learning to Produce and Use Stories of Forces of Nature – Student Teachers

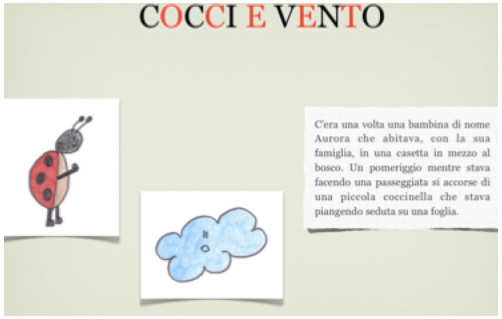
Laboratory Activity on Story Writing…

Participants: 22 students of the *Primary Teacher Education Program* at the University of Modena and Reggio Emilia who volunteered for the 16 hours of "writers' laboratory" after the exams of the physics course.

Structure. Introduction about the interplay between story schema and character schema. Analysis of some case-studies taken from the stories presented for the exam.

Every student…

- Reviews and corrects his/her story created for the physics course exam
- Reviews and corrects a story created by another student
- Designs a didactical unit around a given story (with activities, scheduling, materials, grouping, setting, etc.)
- Writes a new story for the first years of primary school
- Discusses the new story with the course teacher
- Revise the new story according to the suggestions of the course teacher
- Delivers the story…



3. Learning to Produce and Use Stories of Forces of Nature – Student Teachers

Results of analysis of students' stories before and after discussion with the course teacher…

		% before	*% after*
Story schema	Affective involvement	94	100
	Development and ending	94	94
Character schema (FDG aspects)	Quantity	53	76
	Intensity	59	71
	Force/power	41	65
Adequateness	Natural language	100	100
	Length of phrases	100	100
	Images	59	94

3. Learning to Produce and to Use Stories of Forces of Nature – An Example

Stories of forces of nature for children in schools in the region of Modena and Reggio Emilia (Northern Italy)

"When Heaven and Earth Were Created"

The story…

1. sets up a narrative frame;
2. creates emotionally meaningful patterns around the events;
3. encodes important knowledge in metaphorical and memorable form;

A coherent teaching-learning process related to the story…

1. brings metaphors to conscious attention and facilitates their creative use;
2. blends natural experience of the world to personal and affective experience;
3. shapes real world content in an immaginative way and, at the same time, sharpens our scientific eye.

When Heaven and Earth Were Created *tells the story of little Inpu in ancient Egypt. When his parents and his sister go out to the fields early in the morning, he is left behind at home with his grandmother because he is ill with a high fever. His grandmother tells him his favorite story, how heaven and earth were born…*

3. Learning to Produce and to Use Stories of Forces of Nature – An Example

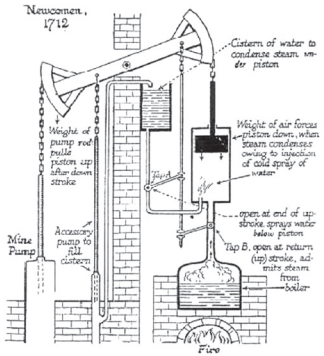
Using the story in school in first grade (students are around 6 years of age)…

After the story…

- Discussing and drawing
- Playing the story
- "Physicalization" of the Forces of Nature
- Scientific Labs directly connected to problems arising from the story
- Games
- Metacognitive activities
- Co-planning of next scientific experience
- Teacher's feedback
- Relaunching activities
- *Narrative Assessment* for learning: childrens' narratives, teacher and self-evaluation

"Long, long ago, a boy named Inpu lived in a village on the river Nile in Old Egypt. Inpu had just turned six years old when one morning, he started to feel unwell. He still helped his mother and his older sister Tameri to get ready for the day but then he became so tired that he just lay down in a corner of their simple home. He started feeling hotter and hotter and worse and worse. His mother came to him, felt his cheeks and said 'Inpu, you are ill. You don't have to help in the field today. We will leave you here with Grandma. You can rest and get better.'"

4. Summary: Nature as a Communicative Partner



Diagrammatic View of Newcomen's Atmospheric or Fire Engine (1712)

Does a Narrative Approach to Nature and Science Change our Interaction/Communication with Nature?

*The **interaction of a human with the physical world** is of a particular form—it leads to the schematic structures descibed by embodied cognition.*

***Linguistic interaction** takes place between humans and has its own form leading to its own abstractions.*

So what happens when we use stories of forces of nature? Does the former interaction—the physical one—change? Do we possibly add a new dimension to this interaction?

*We would like to suggest that we see nature in a new light. It is not any longer this world that is so totally different from our fellow human beings. Nature is filled with agents with whom we can interact—communicate. We feel we are put in a position to **understand and predict the behavior of these agents** (folk physics) just as we wish to predict human behavior (folk psychology).*

*It seems we can have **a conversation with nature**. **Nature becomes a partner not completely unlike our social partners…***

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