Narrative Framing of Natural Scenes— Stories of Forces of Nature and a Model of Perception at Different Scales

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I would like to extend my sincerest thanks and appreciation to ***Federico Corni*** *and* ***Elisabeth Dumont*** *who have been working with me on applications of these ideas…*

…to ***Annamaria Contini*** *who has given our work philosophical weight…*

…and to my wife, ***Robin Fuchs-Washington****, who has been creating* ***stories of Forces of Nature*** *with me.*

A Preliminary Summary in the Form of Some Claims

When confronting ***nature at human scale****, we perceive a perceptual unit I call* ***Force of Nature*** *—* ***heat****,* ***water****,* ***wind****,* ***electricity****,* ***substances****,* ***motion****… are examples of forces of nature.*

Considering spatial, temporal, and systemic ***scales****, force is a* ***medium-scale gestalt*** *between smaller and larger-scale perceptual units. Our understanding of it is mediated by smaller and larger imaginative structures such as* ***metaphor*** *and* ***story****.*

Forces *are conceptualized as* ***agents acting in and suffering through events unfolding over time in story worlds****… We can, and should, tell stories of forces of nature. As a formal science, macroscopic physics can be rendered in narrative form:* ***Models are storyworlds*** *and* ***simulations are stories****.*

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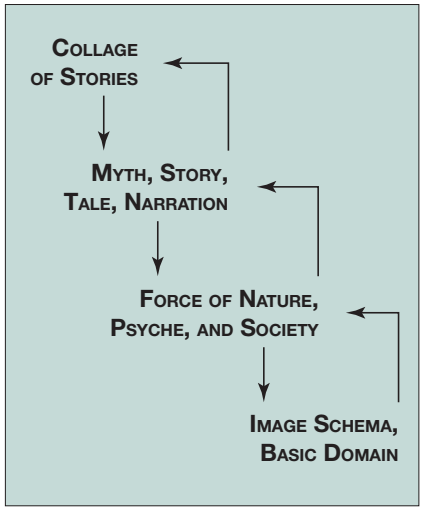


1. Motivation and Background—Questions that have motivated this research...

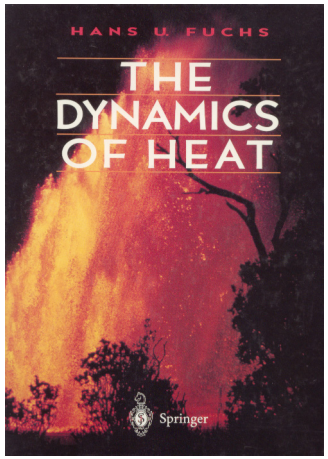
For the last three decades I have tried to find out where our science—especially ***thermodynamics***—comes from and how we can understand and learn it.

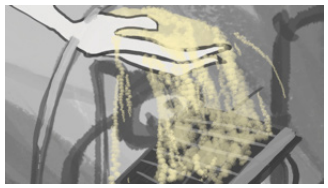
How do humans ***encounter nature***? How do we ***perceive nature at human scale***?

How does ***language***—both natural and formal—relate to all of this?

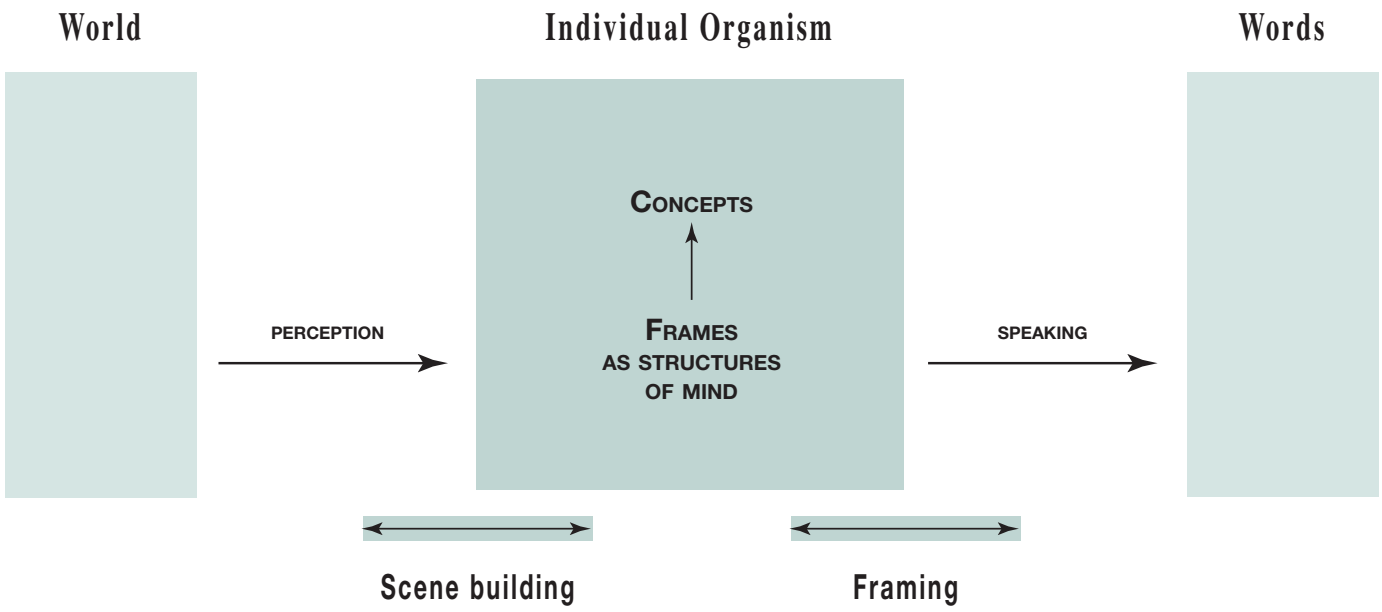
Could we compare the growth of ***understanding of nature*** (***folk physics***) to the growth of our ***understanding of other humans*** (***folk psychology***)? If so, and if Hutto's concept of the ***Narrative Practice Hypothesis*** is correct, should we tell stories of forces of nature to our children?

And how do I design a narrative approach to physical science for twenty-year old engineering students?





1. Motivation and Background — Framing



"I would like to say that people associate certain **scenes** with certain linguistic **frames**."

"I use the word **scene** in a maximally general sense, including not only visual scenes but also […] enactive experiences, body image, and, in general, any kind of coherent segment of human beliefs, actions, experiences or imaginings."

"I use the word **frame** for any system of linguistic choices—the easiest cases being collections of words, but also including choices of grammatical rules or linguistic categories—that can get associated with prototypical instances of scenes."

(Fillmore, 1975, p.124)

1. Motivation and Background — Narrative Framing

The notion of Narrative Framing

I borrow the term ***framing*** from Fillmore in an early sense of bringing together ***perception***, ***conceptualization***, and ***language use***.

The term ***narrative framing*** is used in a double sense:

1. It alludes to ***enlisting narrative intelligence*** in the ***perception*** of phenomena in nature; and
2. speaks of the ***telling of stories*** that contain ***conceptual elements*** used in the creation of scientific models of these phenomena.

→ The notion of ***narrative framing*** rests upon an assumption of ***experience*** and ***perception at different scales***: experience leads to the construction of ***small to large-scale perceptual schemas (gestalts)*** that are recruited for understanding. ***Large-scale schemas support narrative thought and understanding***.

Perceptual Scale…

← *…refers to* ***spatial, temporal,*** *and* ***systemic*** *"size" of perceptual units (gestalts)*

2. Linguistic Phenomena in Macroscopic Physical Science — Temperature

- I am in a ***warmer place*** now.
- Lately, the weather has been ***going from hot to cold***.
- His ***fever has been rising fast***.
- Such a ***high temperature difference*** is not good.
- The ***temperature*** is now ***at the lowest level*** it's been in a while.
- I am ***taking forever to warm up***.
- In front of the fire, the air feels particularly cold—there is a ***great imbalance between hot and cold***.
- The ***temperature drops over a short distance***. This ***creates*** quite some ***stress***.
- […] bodies of water […] differ in their temperatures, providing a ***thermal landscape*** which might serve as an orienting cue in fish migration.
- The truth is, all of these ***thermal ups and downs*** are perfectly normal…

Expressions paint an image of the meaning of ***temperature concepts*** *with the help of* ***images***, ***figures***, *or* ***shapes***. *Observe that expressions contain* ***words*** *and suggest* ***concepts*** *that* ***are embedded in a larger meaning structure***…

2. 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****:*

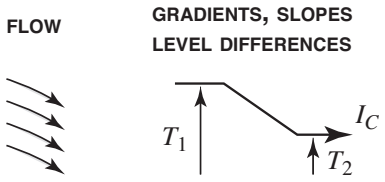
- Container, store, hold, accumulate; lack of, abundance of; collect
- Flow, transport, extract emit/absorb, exchange; heat moves
- Balance (law of balance of…)
- Use, produce, generate heat
- Heat as location, landscape; level, intensity, degree, scale of heat
- Balance of heat and cold, hot and cold; 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…

2. Linguistic Phenomena in Macroscopic Physical Science — Heat in Continuum Physics

Equations and Imaginative Structures in Heat Conduction

Images of Quantities



Equations for Energy for Conductive Transport

$$\frac{\partial}{\partial t}\rho_E = -\frac{\partial}{\partial x} j_E$$

$$j_E = T\, j_C$$

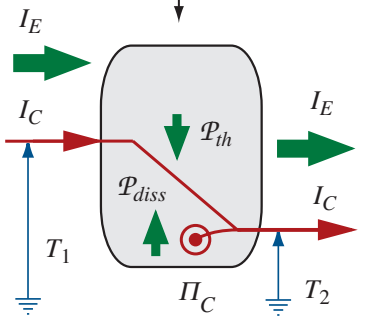
Equation of Balance of Caloric

$$\frac{\partial}{\partial t}\rho_C = -\frac{\partial}{\partial x} j_C + \pi_C$$

$$\Rightarrow \quad \frac{\partial}{\partial x} j_E = j_C \frac{\partial T}{\partial x} + T\,\pi_C = 0$$

Difference of energy flows into and out of a region

Image of Power: Energy Released in the Downhill Flow of a Fluid Like Quantity



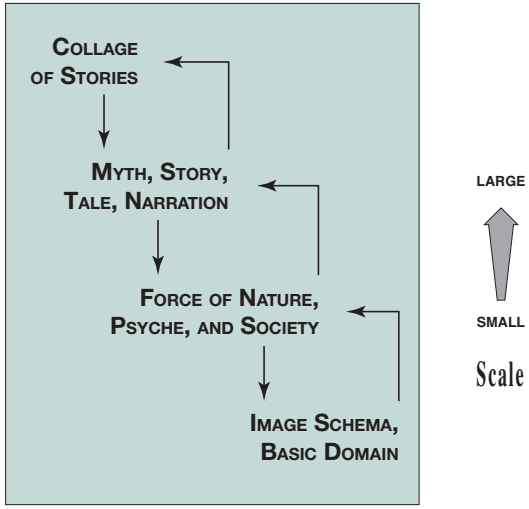
Waterfall Image (Sadi Carnot)

2. Linguistic Phenomena in Macroscopic Physical Science — Scales

From small to larger linguistic products…

We say things that can be ordered according to increasing length (of utterances). Longer linguistic products, when analyzed, are seen to contain more figurative elements and more complex imaginative structure…

1. It was cold.
2. The temperature fell rapidly.
3. Cold found its way through the cracks in the walls and was collecting inside.
4. For cold it seemed to be fun when it could make a warm place cold.
5. So much cold was sneaking in through the walls that only the roaring fire in the wood burning stove could keep it at bay.



2. Linguistic Phenomena in Macroscopic Physical Science — Scales

From small to larger linguistic products…

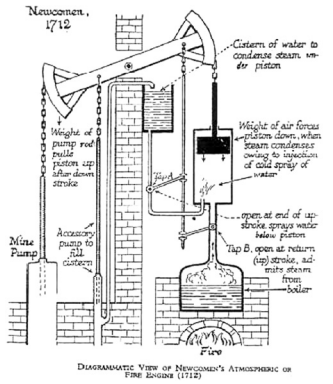
6. *R. Fuchs and H. Fuchs:* ***A Winter Story***. As the last of the warmth of late Fall left the plain surrounding Little Hollow, cold found its way into the area and spread out. […] The cold of winter knew a good place where it could do its job of making everything and everybody cold […] It could flow 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.

2. Linguistic Phenomena in Macroscopic Physical Science — Scales

From small to larger linguistic products…

7. *Sadi Carnot (1824):* ***Réflexions sur la puissance motrice du feu***. Every one knows that heat can produce motion. That it possesses vast motive-power no one can doubt, in these days when the steam-engine is everywhere so well known. To heat also are due the vast movements which take place on the earth. It causes the agitations of the atmosphere, the ascension of clouds, the fall of rain and of meteors, the currents of water which channel the surface of the globe, …. Even earthquakes and volcanic eruptions are the result of heat.

8. *Sadi Carnot (1824)*. According to established principles at the present time, we can compare with sufficient accuracy the motive power of heat to that of a fall of water […] . The motive power of a fall of water depends on its height and on the quantity of the liquid; the motive power of heat depends also on the quantity of caloric used, and on what may be termed, on what in fact we will call, the height of its fall, that is to say, the difference of temperature of the bodies between which the exchange of caloric is made.



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

3. Forces of Nature and Their Stories – Examples and Origins

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

Origin of the* ASPECTS *of the notion of force…

It appears that the ***perception of a polarity*** lies at the heart of the notion of a force. Polarity → ***tension***: difference of qualities/intensities conceptualized by the SCALE schema.

← Aspect of **intensity**

We further notice that ***phenomena/events/processes*** are associated with the occurrence of a polarity or tension → ***causal interaction*** between phenomena resulting from tensions.

← Aspect of **power**

The human mind then seems to construct the image of an associated ***agent of certain size*** (← Figure-Ground Reversal) ***and power***.

← Aspect of **quantity**

3. 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.*

3. Forces of Nature and Their Stories – Justice

*Examples of expressions involving **justice**. Examples have been found in the Internet:*

- I don't think there is ***much justice*** in the world.
- The ***source of justice***.
- "Justice denied anywhere ***diminishes justice*** everywhere." (Martin Luther King, Jr.)
- ***Harsh*** justice puts lives in the balance.
- "I have always found that mercy ***bears*** richer fruits than ***strict justice***." (A. Lincoln)
- The ***healing power*** of justice.
- ***Justice compels*** us to help this state find a way to serve all its people…
- Hence ***justice hinders*** theft of another's property.
- Create an ***imbalance*** in our justice system…
- How to ***distinguish justice from injustice*** in our characters.
- He ***got the justice*** he deserved.
- With this move we are ***coming closer to true justice***.

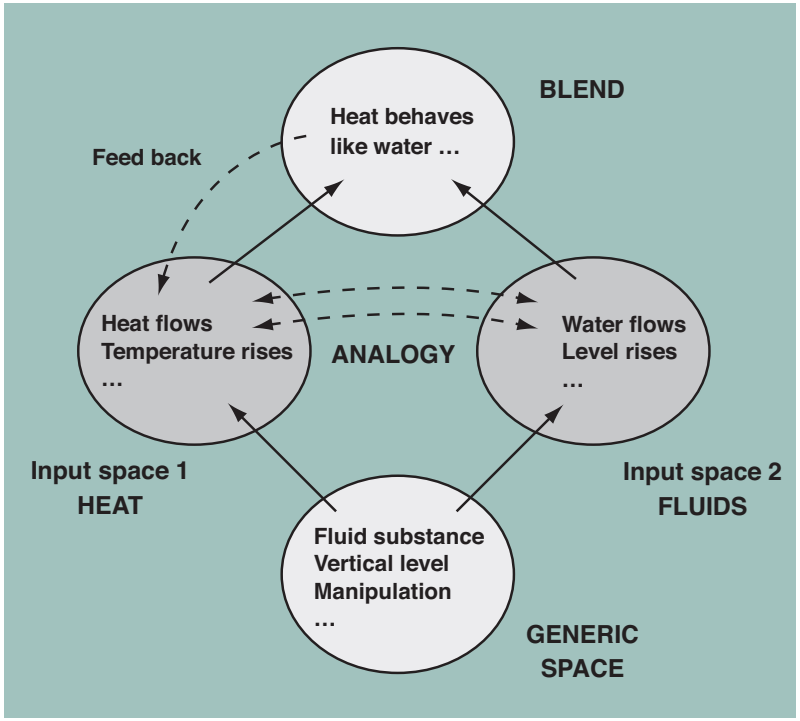
Figure-Ground Reversal

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

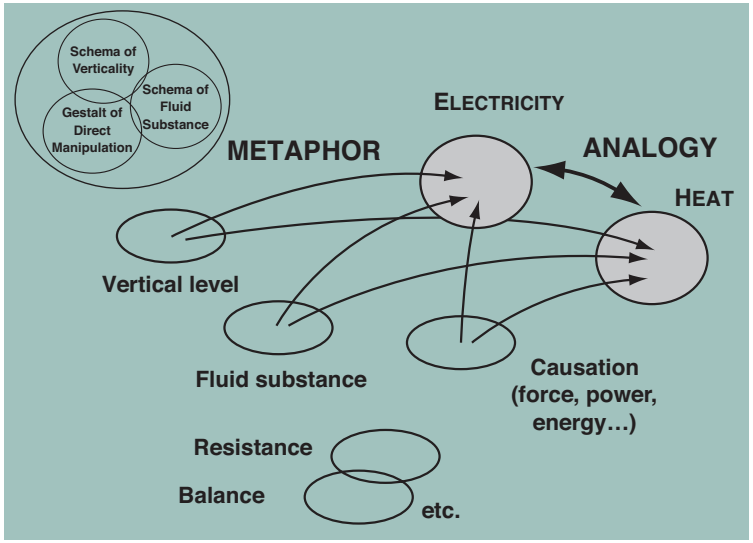
- Container, store, hold, accumulate; lack of, abundance of; collect
- Flow, transport, exchange justice
- Use, produce, generate justice
- Level, intensity, degree, scale of justice
- Tension/balance of justice and injustice
- **Power, force of justice**
- **Justice is an agent: causes, drives, makes, counteracts, lets, balances**
- **Justice is a patient: force, make, counteract, block, hold (back), enable, prevent, oppose, let/allow justice**

Justice is a powerful agent…

3. Forces of Nature and Their Stories — Metaphors, Blending, Analogy



Mirror Integration Network (Turner, 2006, p.101; Fauconnier, 1997, p.18-25) represents structures "popping up" in discourse and thought and eventually lead to ***stable conceptualizations***. →



Basic ***stable conceptual structure*** of the perceptual gestalt of ***Force of Nature*** applied to differenc phenomena. The gestalt has three fundamental aspects: ***Quality/Intensity***, ***Quantity/Size***, and ***Power***. →

Analogy: Different ***Forces of Nature*** are ***structured metaphorically in the same manner***. This makes them similar to the human mind.

3. Forces of Nature and Their Stories — Model/Simulation and Storyworld/Story

Origin of the notion of force…

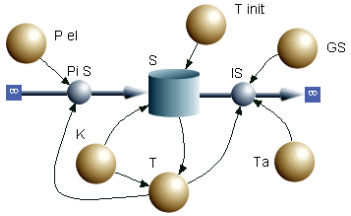
It appears that the ***perception of a polarity*** and related ***tension*** lies at the heart of the notion of ***force***…

The human mind then seems to construct the image of an ***agent of certain size and power reacting to tensions***.

Rendering phenomena involving these forces in narrative form:

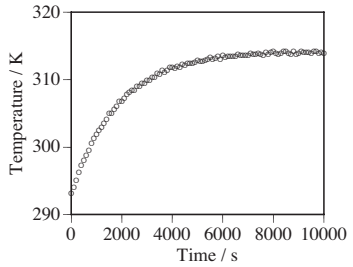
- ***Models as storyworlds***
- ***Simulations as stories***

Story-World & Dynamical Model



Story & Simulation

Once upon a time there was a small town called Little Hollow. Children and grown ups in Little Hollow were waiting for winter…



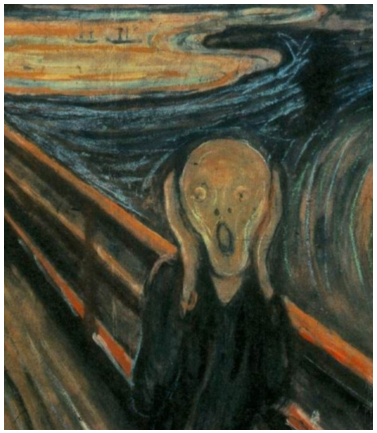
3. Forces of Nature and Their Stories — Origins

The Perceptual Gestalt of Force

Force does not just apply to perception of natural events—it equally applies to social and psychological phenomena.

It is possible that we become conscious of forces largely because of perception of an "inner" world in dreams and trances the knowledge of which we transfer to the world "out there."

We may conjecture that this type of perception helped drive the development of language in mythic societies.

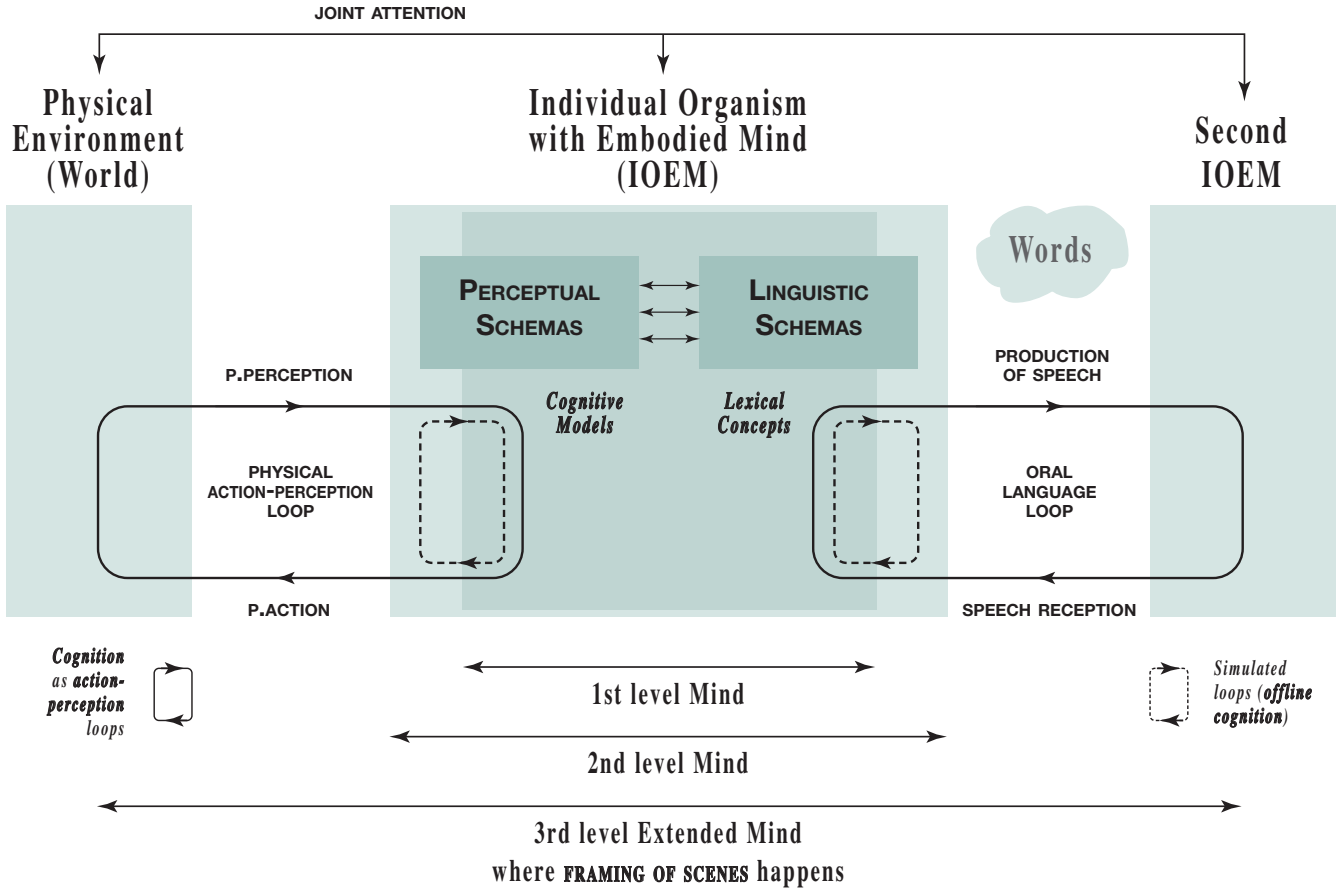


4. Perception at Different Scales — Action-Perception-Feedback-Loops

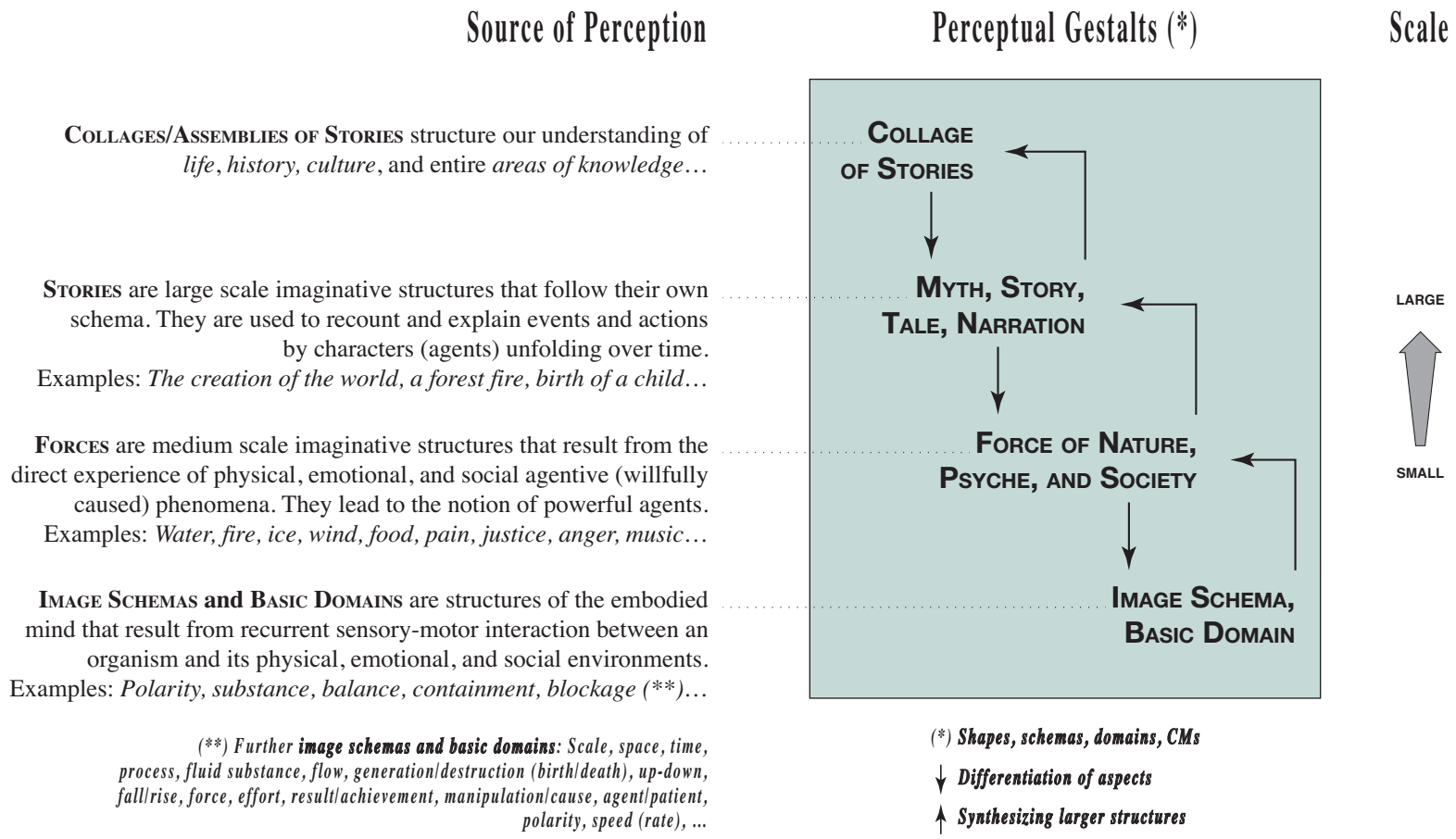
Cognitive semantics and a model of embodied minds

*"I mean by framing the appeal, in **perceiving, thinking, and communicating**, to structured ways of interpreting experiences."*

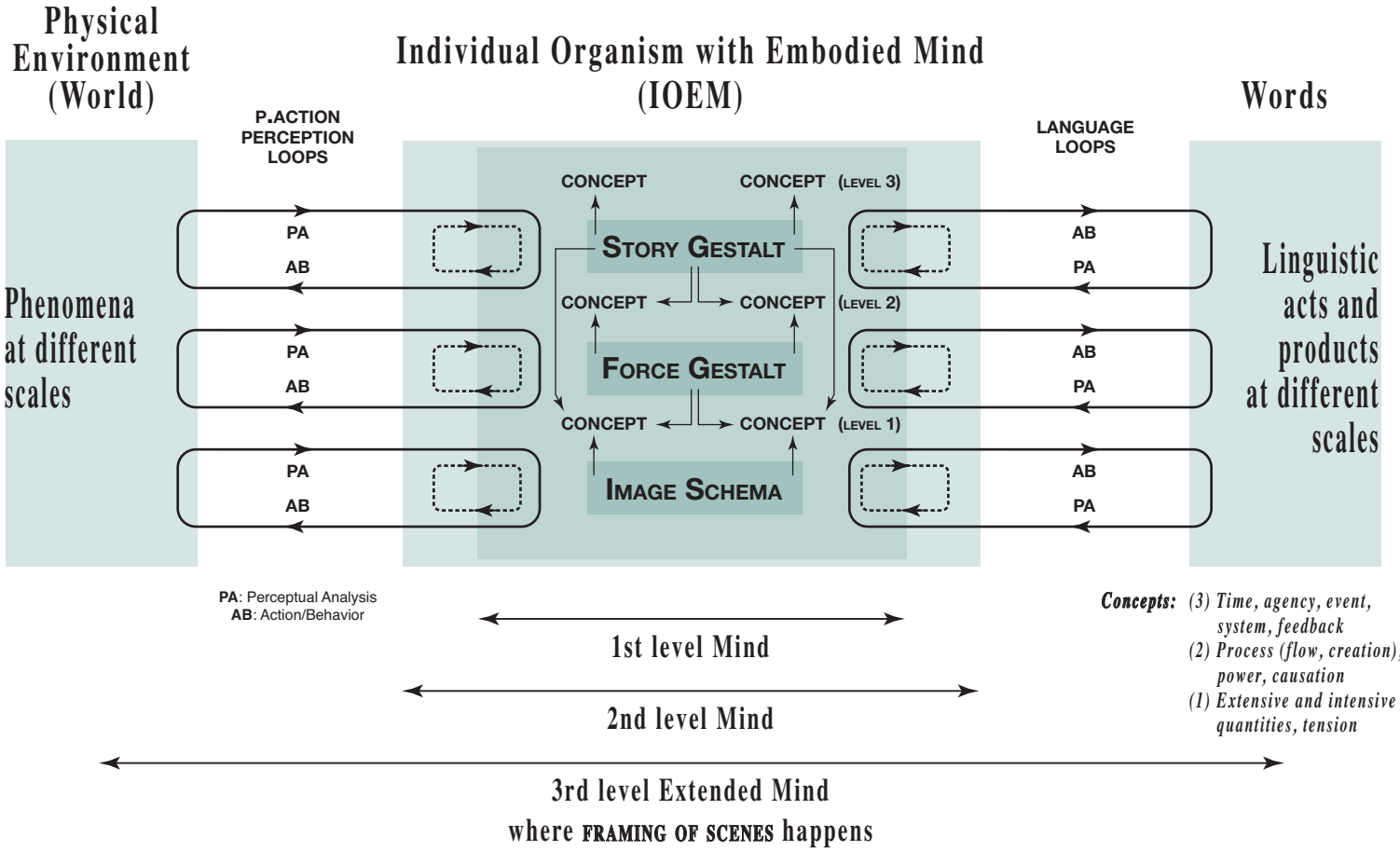
(Fillmore, 1976, p. 20)



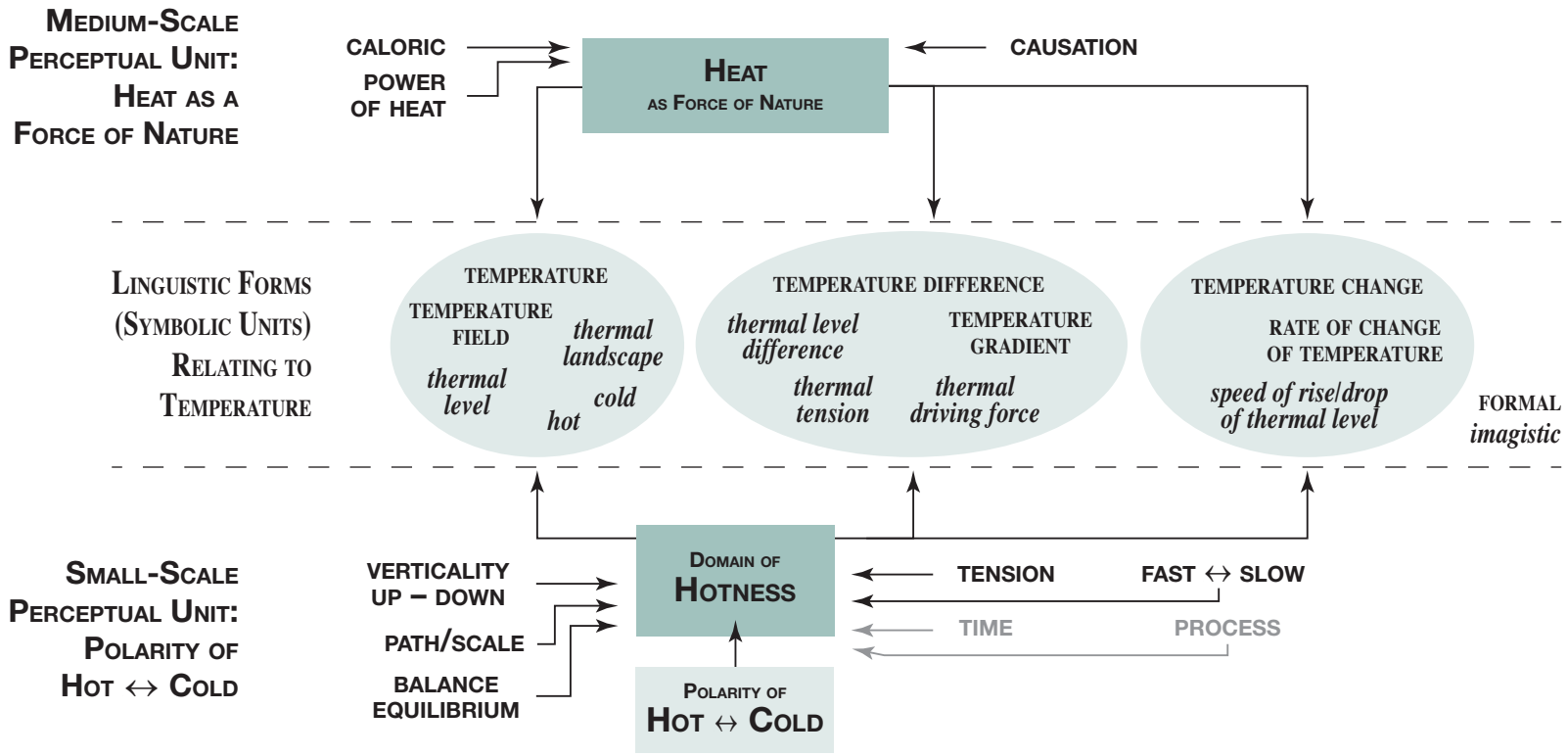
4. Perception at Different Scales — Small- to Large-Scale Schemas



4. Perception at Different Scales — Action-Perception-Loops at Different Scales



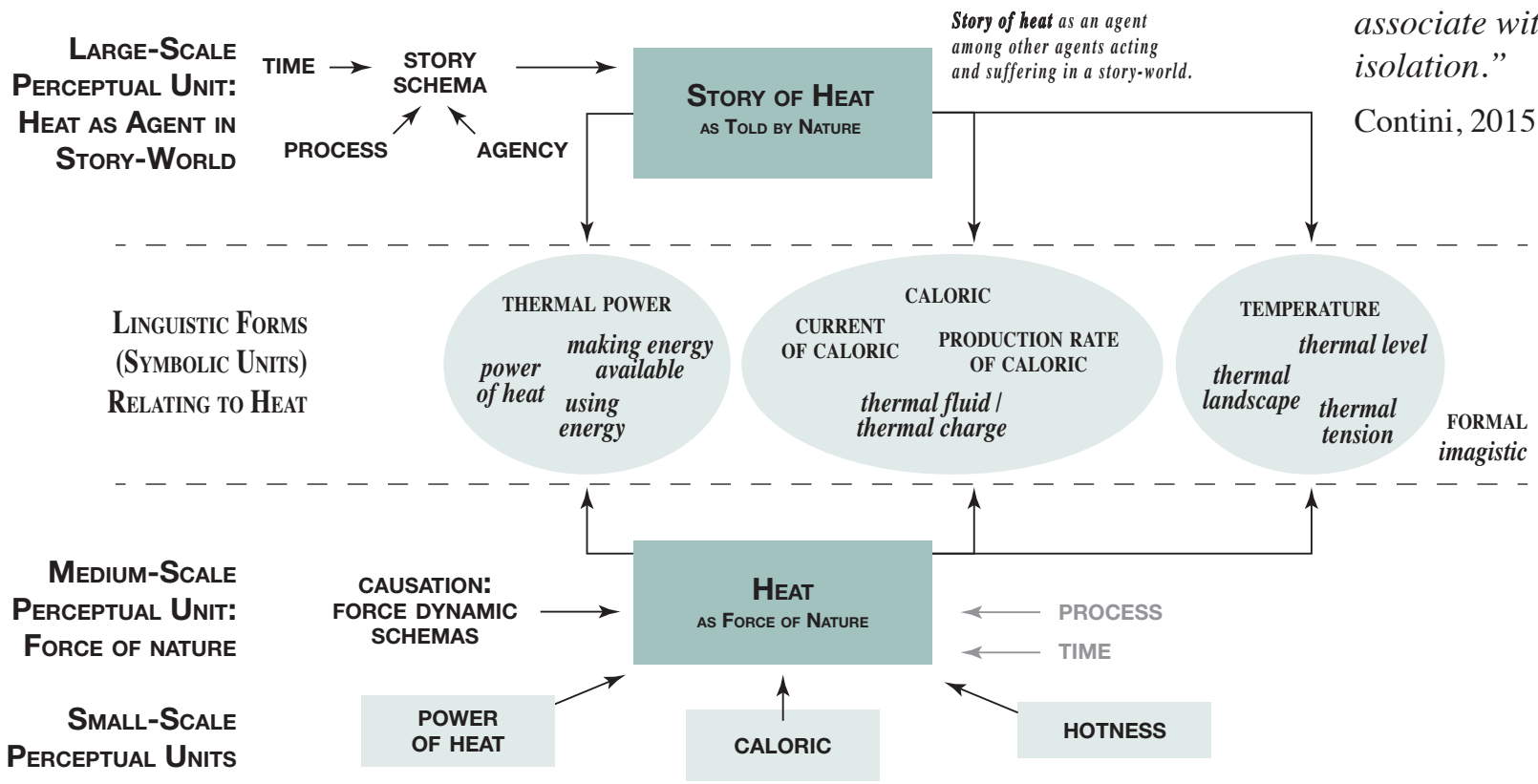
4. Perception at Different Scales — Temperature Concepts



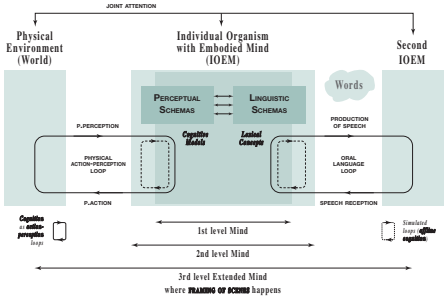
4. Perception at Different Scales — Heat Concepts

"… 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



4. Perception at Different Scales — Nature as a Communicative Partner



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?

*I 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…***

4. Perception at Different Scales

Some observations…

- ***Force of nature*** is an example of a ***medium-scale perceptual whole*** that is ***structured metaphorically from below*** and ***informed*** in important ways ***from above by narrative structures***.
- More than any other thermal concept, ***the concepts of caloric and its power only grow out of the large-scale (narrative) perception of thermal processes, including the perception of heat as a force (of nature)*** → notions such as ***time***, ***process***, ***agency***, ***power***, etc., crucially ***depend upon the large-scale perspective*** (they are not just, or not at all, simple inputs for the story-schema; rather, they emerge from the narrative form).
- ***Where does the notion of quantity of heat (caloric) come from?*** Direct perception seems impossible—the concept appears to be the ***result of imagination*** (stimulated by perception of ***agency*** as a general schema and of thermal agency as the concrete case; plus the action of ***Figure-Ground Reversal***). However, fire and ice (with their aspect of size) may just be perceived as ***material instantiations of heat and cold***.

"…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

5. Summary

- ***Framing*** (frame semantics) is an approach to modeling the human mind in ***contrast to truth conditional semantics***. It states that ***meaning is conceptualization***. It is in accord with the theory of ***embodied cognition***.
- The notion of ***narrative framing*** rests upon an assumption of ***experience*** and ***perception at different scales***: perception leads to the construction of ***small to large-scale perceptual gestalts*** that are recruited for understanding. ***Large-scale schemas support narrative thought and understanding***.
- ***Concepts are understood*** not only in terms of conceptual structures constructed from (smaller) parts but also by being ***embedded in larger wholes***.

Lessons learned from the semantics of natural languages will apply to our understanding of science (in production and learning)…

→ ***If we want to understand heat (or momentum, or electricity), we need to tell stories***. We need to learn to understand what they are doing, how they ***affect the world*** and how, in turn, they are ***affected by the world*** (agency).

→ ***Forces of nature are agents*** in (macroscopic physical) ***story-worlds***. In formal science, story-worlds take the form of formal ***dynamical models***. ***Simulations*** of these models correspond to ***concrete stories***.

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