

# Neural Darwinism, Neuroscience, and Cognitive Grammar

## Lecture 10

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*Sherman Wilcox — Beijing, China*

# Cognitive Neuroscience: The Moving Brain

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- ❖ Language is a complex activity. The various facets of this complex activity — motor, perceptual, and cognitive — are implemented by neural processing, and so ultimately our theories of language have to articulate with theories of brain activity.



# Three Brain Theories

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- ❖ Gerald Edelman, *Neural Darwinism: Theory of Neuronal Group Selection*
- ❖ Rudolfo Llinás, *I of the Vortex: From Neurons to Self*
- ❖ Alain Berthoz, *The Brain's Sense of Movement*

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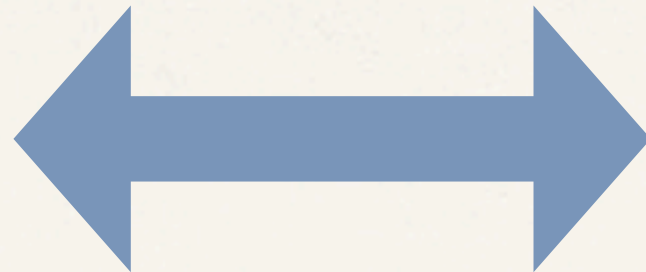


Neural Darwinism



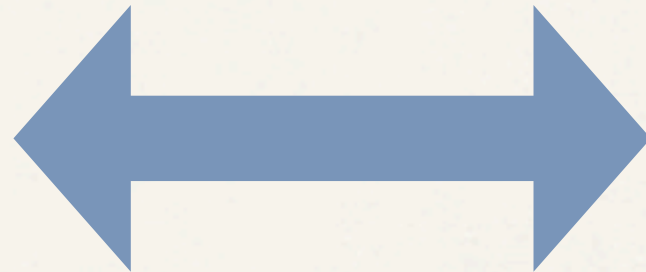
Dynamic System Theory

Neural Darwinism



Dynamic System Theory

Neural Darwinism



Cognitive Grammar



# Neural Darwinism and Dynamic System Theory

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- ❖ Edelman's neuronal theory is a non-dualistic, non-Cartesian brain theory.
- ❖ One of its goal is to account developmentally and evolutionarily for the emergence of language as an emergent phenomenon.

# Neural Darwinism and CG

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- ❖ It is *selectionist* rather than *instructionist*: in this sense, it is a 'usage-based' rather than an 'a priori' or 'innatist' theory of brain development and function.
- ❖ A number of basic principles of Neural Darwinism are compatible with basic principles of Cognitive Grammar



# Four Principles of Neural Darwinism

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- ❖ Concepts
- ❖ Reentry
- ❖ Degeneracy
- ❖ Gesture

# Neural Darwinism and Concepts

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- ❖ “The present theory holds that both during evolution and in the individual, concepts precede language and meaning. Concept formation, according to the view I am developing here, precedes semantics. Concepts are driven by the perceptual apparatus, are constructed by the brain, and require memory. They are coherent and can correspond to things and actions.”



# Neural Darwinism and Concepts

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- ❖ Concepts and language: “One is constantly tempted to consider concepts as properties of language. But this is not so .... It is important to resist the temptation to think that concepts are merely mental images or (even worse) that they themselves are the ‘language of thought’.”

# Neural Darwinism and Concepts

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- ❖ Concepts precede language. They are driven by and emerge from perception. They can correspond to **things** and **actions**:
  - ❖ “An animal capable of concepts is able to identify a particular *thing* or *action* and control its future behavior on the basis of that identification.”
- ❖ Concepts serve as bases for image schemata (“object,” “motion,” “barrier,” “container,” etc.).



# Neural Darwinism and Concepts

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- ❖ **Concepts in Neural Darwinism are compatible with Conceptual Semantics in Cognitive Grammar**
- ❖ Semantics is conceptualization exploited for linguistic purposes.
- ❖ It is grounded in perception and bodily experience
- ❖ CG rejects a propositional semantics, instead favors a more *imagistic* account.



# Neural Darwinism and Concepts

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- ❖ **Minimal concepts** in domains of experience such as space, vision, time, kinesthetic sensation.
- ❖ **Configurational concepts** such as contrast, boundary, change, continuity, inclusion, proximity, and so forth.
- ❖ **Conceptual Archetypes** are experientially grounded concepts such as physical object, an object in a location, an object moving through space, the human body, the human face, seeing something, holding something, handing something to someone, exerting force to effect a change, and so forth.



# Neural Darwinism and Reentry

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- ❖ The neural interrelation of many simultaneous perceptual and motor representations.
- ❖ Reentry accounts for the coordination of perception across many sensory modalities.

# Neural Darwinism and Reentry

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- ❖ “Reentry is a process of temporally ongoing parallel signaling between separate maps along ordered anatomical connections.” (49)



# Reentry and Encyclopedic Semantics

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Reentry and Multimodal Experience



# Reentry: Encyclopedic Networks

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- ❖ Knowledge is encyclopedic, consisting of networks of concepts with no sharp boundaries between semantic and pragmatic, combining experience from multiple sensory modalities and our physical interaction with the world.



# Neural Darwinism and Degeneracy

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- ❖ Degeneracy is the ability of elements that are structurally different to perform the same function or yield the same output.
- ❖ A critical feature of degeneracy is that *different structures* have similar consequences.
- ❖ Degeneracy is pervasive in biological systems
- ❖ Degeneracy is not the same as redundancy



# Neural Darwinism and Degeneracy

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## Degeneracy at different levels of biological organization

Genetic code (many different nucleotide sequences encode a polypeptide)

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Food sources and end products (an enormous variety of diets are nutritionally equivalent)

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Sensory modalities (information obtained by any one modality often overlaps that obtained by others)

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Body movements (many different patterns of muscle contraction yield equivalent outcomes)

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Interanimal communication (there are large and sometimes nearly infinite numbers of ways to transmit the same message, a situation most obvious in language)

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# Degeneracy and Language

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Different paths of grammaticization result in the same function: 6 routes to the development of passives (Givón, *The Genesis of Syntactic Complexity*)

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Metaphor and polysemy (different structures accomplish the same function)

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Construal (different construals of the same objective scene accomplish the same function)

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Different lexical / morphological / syntactic structures accomplish the same function (e.g., verb aspect)

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# Degeneracy and Construal

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- ✧ Different ways of viewing a particular situation (perspective, point of view, subjectivity) yield the same communicative function.



# Degeneracy and Construal

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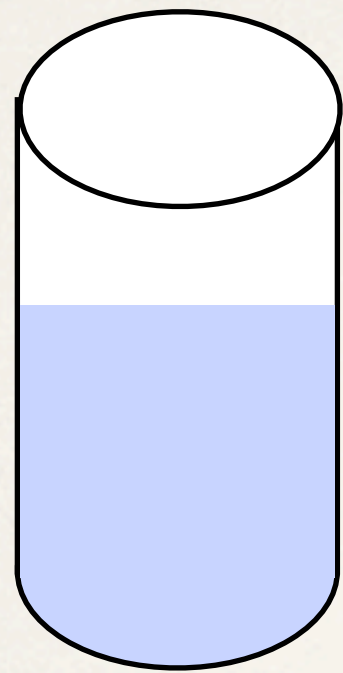
- ❖ Different ways of viewing a particular situation (perspective, point of view, subjectivity) yield the same communicative function.
- ❖ Distinction between **conceptual content** and the **construal** of that content.

# Degeneracy and Construal

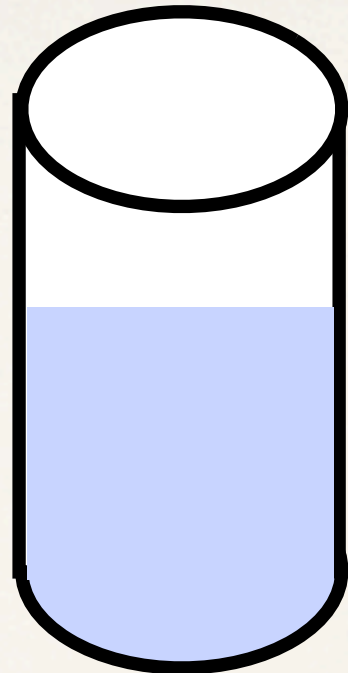
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- ❖ Different ways of viewing a particular situation (perspective, point of view, subjectivity) yield the same communicative function.
- ❖ Distinction between **conceptual content** and the **construal** of that content.
- ❖ Multiple disjunctive glosses on the same reality: “The water is in the glass,” “The glass contains the water,” “The glass is half full,” “The glass is half empty.”

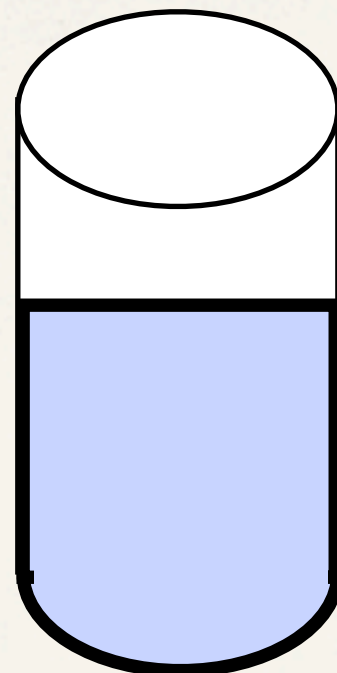




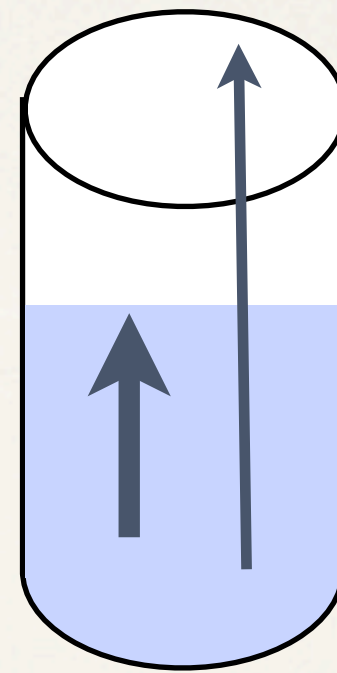
conceptual  
content



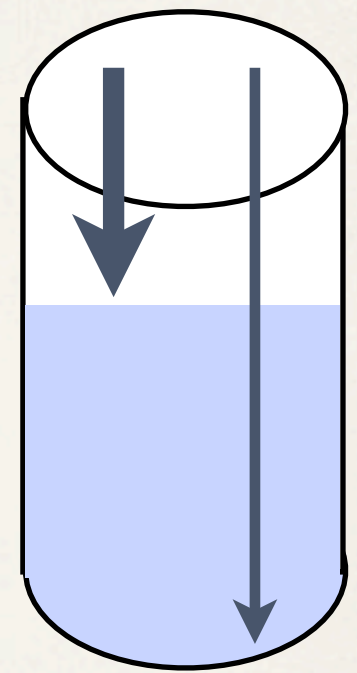
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1. *the glass with the water in it*
2. *the water in the glass*
3. *the glass is half-full*
4. *the glass is half-empty*

# Grammatical Degeneracy

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- ❖ “I will leave for Rome tomorrow.”
- ❖ “I’m gonna leave for Rome tomorrow.”
- ❖ “I leave for Rome tomorrow.”



# Grammatical Degeneracy

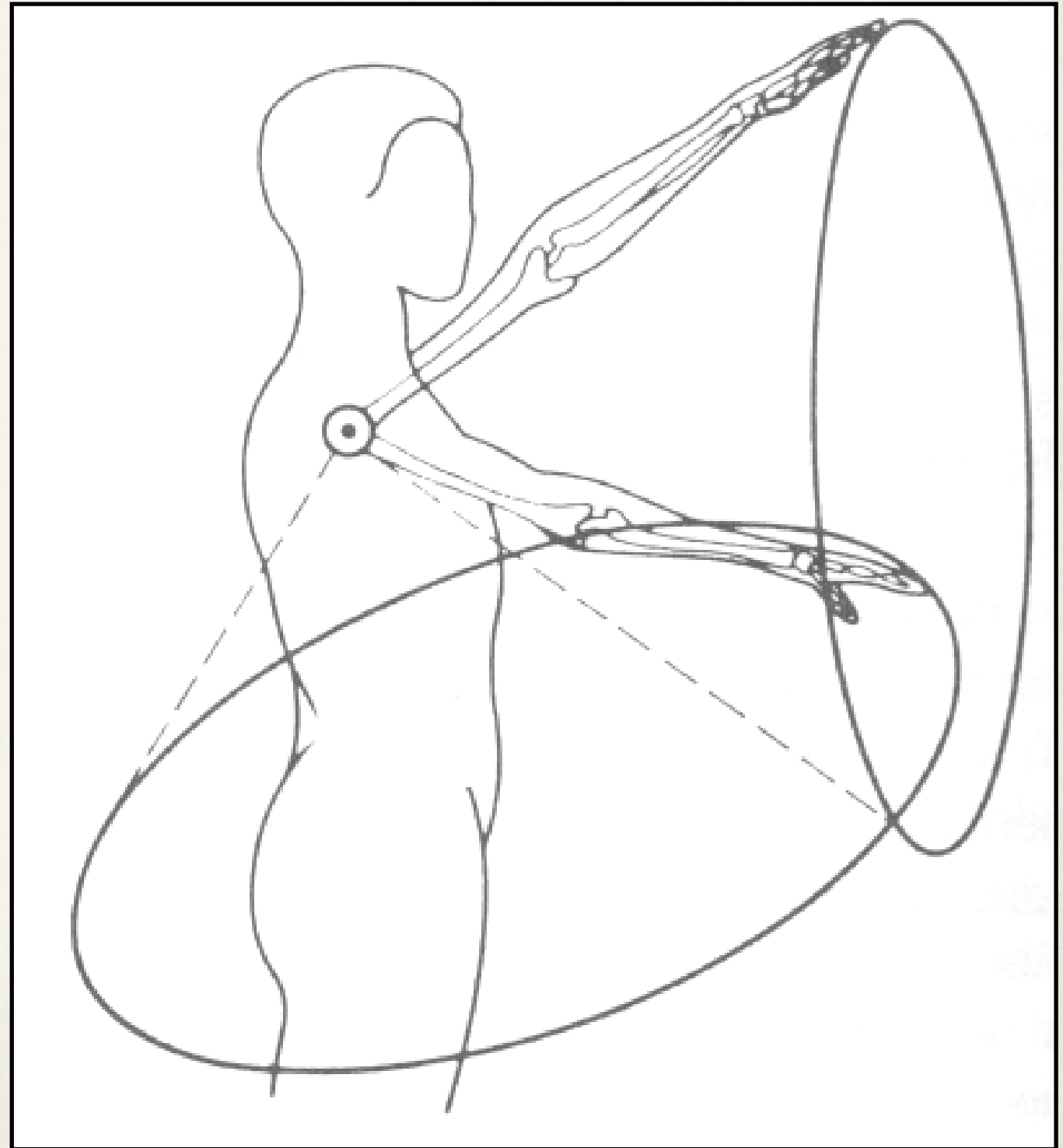
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- ❖ Languages like English can use both lexical and *aktionsart* structures to accomplish the same verb aspectual function:
  - ❖ ‘punch over and over’ vs. ‘pummel’
  - ❖ ‘rap again and again’ vs. ‘hammer’
  - ❖ ‘become more and more bright’ vs. ‘brighten’
  - ❖ ‘come to know’ vs. ‘realize’

# Degeneracy and Body Movements

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- ❖ **Body movements:** many different patterns of muscle contraction yield equivalent outcomes.

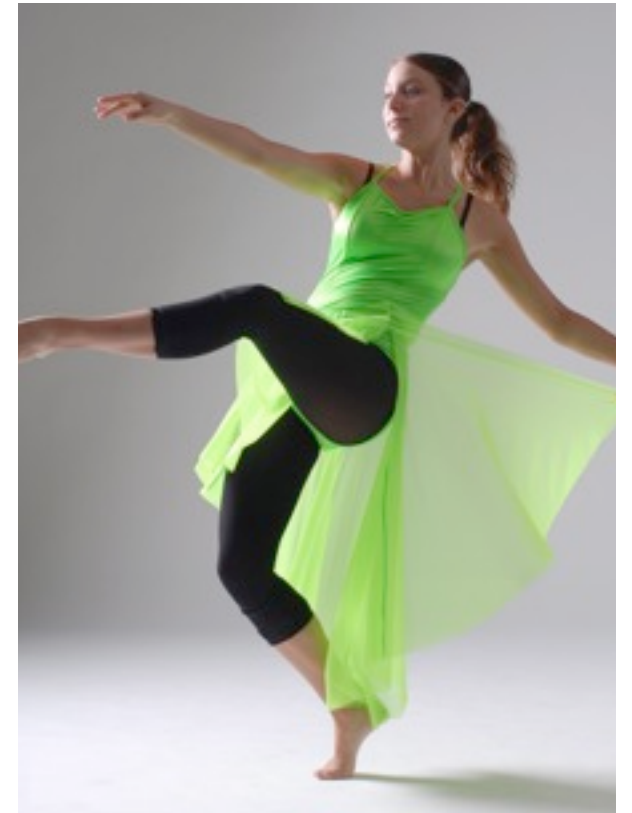
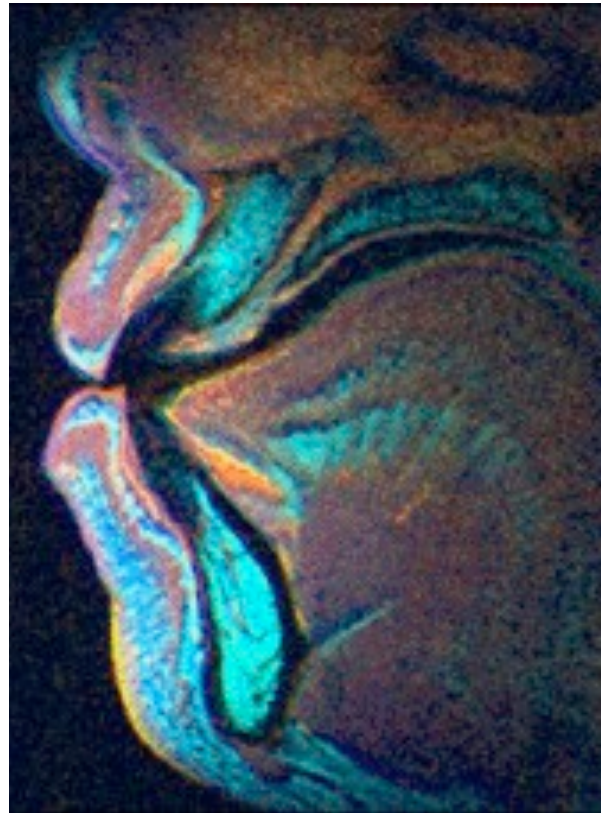




# Degeneracy and Articulatory Gestures

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- ❖ Articulatory gesture: “A gesture is a functional unit, an equivalence class of coordinated movements that achieve some end.”
- ❖ Muscle synergies are *classes of movement patterns* or gestures. Synergies are not controlled in a one-to-one fashion but are tightly constrained among themselves, sharply reducing the number of degrees of freedom of movement.
- ❖ The same function is accomplished by different sets or classes of muscle synergies.
  - ❖ Ex: bite-block speech, opening a door with objects in your hands or under your arm.



# Seeking Unification

Setting Language in Motion



- ❖ I started by suggesting that it is possible to seek unity by finding and revealing hidden likenesses. One of my goals in this search is to unify signed language, spoken language, and gesture — as *skilled performances*.

# The cognitive linguistic view

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Embodied conceptualization “grounded in our experiences as creatures with bodies who interact with the world through physical processes involving sensory and motor activity.”

(Langacker, *Cognitive Grammar*, 2008: 524)











# Language and Cognition as Action

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# Language and Cognition as Action

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- ✧ **Setting Language in Motion:** Language is a skilled performance



# Language and Cognition as Action

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- ✧ **Setting Language in Motion:** Language is a skilled performance
- ✧ **Setting the Mind in Motion:** Cognition is a skilled performance

“In a nutshell ... the human mind is constantly in motion.”

(M. Spivey, *The Continuity of Mind*, 2008)



❖ “At bottom, thinking is the evolutionary internalization of movement.”

(R. Llinás, *I of the Vortex*, 2001)

The image of the mind, of the brain, that I want to leave you with is of a brain that evolved to serve actively moving creatures...







*"Last week's potatoes."*



“The radioactive phosphorus content of the cerebrum of the rat decreases to one-half in a period of two weeks.” Now what does that mean?

It means that phosphorous that is in the brain of a rat — and also in mine, and yours — is not the same phosphorus as it was two weeks ago. It means the atoms that are in the brain are being replaced: the ones that were there before have gone away. So what is this mind of ours: what are these atoms with consciousness?



“Last week’s potatoes!

They now can *remember* what was going on in my mind a year ago — a mind which has long ago been replaced.

To note that the thing I call my individuality is only a pattern or dance, that is what it means when one discovers how long it takes for the atoms of the brain to be replaced by other atoms. The atoms come into my brain, dance a dance, and then go out — there are always new atoms, but always doing the same dance, remembering what the dance was yesterday.”



- ❖ Language and mind are complex *patterns of activity*, dances with constantly changing actors, but who perform the same dance. We will only understand language and the mind when we see language and cognition as *skilled performances*.







