Origins of language: neurobiological evolution, socio-cultural development and their interactions

Japanese-French Frontiers of Science (JFFoS) Symposium

Christophe Coupé
Laboratoire Dynamique du Langage (CNRS - Université Lyon 2)
Overview

The problem
Understanding the origins of language and modern cognition

Trying to solve the problem
Neurobiology… and beyond?

“Extended” frameworks of the emergence of language
What are we looking for?

The capacity for *speech*?

The capacity for *linguistic structures*?

An ability for *syntax*? (recursion)

A *symbolic capacity*? (semantics - semiotics)
What is means to be human (partially…)

Each animal lives in its own world of experiences, constrained by its brain and cognition

*Its Umwelt*

A view from semiotics: the Umwelt as a dense invisible *web of signs*

Sign: something standing for something else for someone

For the tiger, the footprints of a deer indicate where the food went…

For the bat, ultrasounds bouncing back indicate where obstacles are…

Humans are very good at signs...

The notion of *symbol*: something which stands for something else *given an established convention*
Language, culture and symbols

“What’s in a name? That which we call a rose. By any other name would smell as sweet.” (Romeo & Juliet, II,ii, 43)

- **Words** are symbols
- Modern human lives & cultures are **full of symbols**
  - “Cognitive modernity” in paleo-anthropology
When did the symbolic ability and language emerge?
Entangled perspectives

Neuroscience

Sylvian fissure

Parietal lobe

Occipital lobe

Kanzi & friends

Talking robots and virtual agents (e.g. Steels’ Talking Heads)

Archaeological cues

Neurobiology... and beyond?
Brain, language and cognition do not FOSSILIZE

How to study their past developments?
What does neurobiology offer?

To some (good) extent how “it works” at the substrate level… in *modern* humans and animals

The capacity for *speech*?

The capacity for *linguistic structures and symbols*?
Peripheral neural aspects of language

Motor control of the tongue
Kay & al. (1998) *PNAS* 95(9):5417-9

Relate neural aspects of speech to specific skeletal features

- Allows comparing live humans or apes with (pre) humans from the past
- Inferences on the neural development of speech

Enhanced breathing capacity
Central neural aspects of language (1): Development of brain areas

Prefrontal areas - planning and inhibition of behavior - useful to language (and symbols)?


Shape of the skulls + imprinting of blood vessels
Central neural aspects of language (2):
Reorganization of functions in brain areas

**In monkeys:**
- BA 44 + BA 6: mastication
- anterior cingular gyrus: vocalizations

**In humans:**
- Broca’s Area (~BA 44): control of vocal production
- SMA: rhythmic opening & closure of the mouth

Central neural aspects of language (3): Mirror neurons

- Monkey see, monkey do... at the neural level!

Response of a “grasping” mirror neuron:

Gallese et al. (1996) *Brain* 119:593-609

Again, what does neurobiology offer?

Some relevant neural “building blocks” on which to base hypotheses about the development of human cognition.

Many of these building blocks already exist in “earlier” species...
The limits of neurobiology

The Darwinian framework
From the common ancestor with apes to modern humans:

Gradual evolution: under which external constraints and selective forces?

Pre-adaptations:
- apes, monkeys, mammals are “full” of pre-adaptations for language
- when and why did they start playing new roles?
- how did the mosaic integration take place?
- why only us?
The limits of neurobiology

If symbols are what matter (for language and beyond)

Where are symbols in the brain?
Do not forget psychology!

Beware of careless reductionism if no convincing correlation between the physiological and psychological levels

- We lack knowledge to bind sophisticated theories of the mind with neural networks, especially for prehistory
  - especially nice theories for human cognition
    - e.g. Fauconnier & Turner, 2001
Neurobiological evolution & socio-cultural development

Intricate histories

125,000 BP
Speciation event
emergence of *Homo sapiens*
Anatomically modern
Culturally not modern

50,000 BP
Symbolic Revolution
Cultural modernity

Mutations?
(Klein, 1999)
Neanderthals not modern at all

Speciation event
emergence of *Homo sapiens*
Anatomically modern
Culturally modern, but few traces

McBrearty, & Brooks (2000)

Symbolic Revolution (in Europe only?)
Cultural change?

Less research in Africa?
Sporadic behavior only?

Encounter with Neandertals?

Neanderthals capable of modern behaviors
To which extent lies symbolism and “modern language” in neurobiology?

Where do such developments take place?
“Extended” frameworks of the emergence of language
Windows to the past…

Deciphering our ancestors’ minds?

To this end, we’ve got…
archaeological residues of past activities
How do they relate to the mind, and to the brain?

First traces of symbolism

The issue at hand

Bridging the gap between the brain, the mind, and the outside world

Distributed cognition

Semiotics
Cognition outside the head

➢ A 3rd revolution in cognitive science?
  ✓ Distributed cognition: cognition does not take place only inside the head, but also outside!
    • where representations are stored, conveyed and processed

Landing procedure: requires the analysis of the whole cockpit

✓ Spreading new ideas to neighboring fields

“Raw” and “cooked” properties of signs carriers

- How do we conceptualize the media conveying signs?
  - From physical to properties (gradually) elaborated by the users

- Comparisons between different situations and carriers
  - Early markers of social identity, language & the birth of photography
    - Cheap mechanical reproducibility & the perception of value (Benjamin, 1936)

Pigments

Beads

Tattoos

Blablabla...

Language

Kuhn et al. (2001) PNAS 98:7641-7646
Vanhaeren et al. (2006) Science 312:1785-1788
Is it operational?

- The idea is nice theoretically, but does it produce something new and concrete?
  - (Hutchins, 2005, 2006): yes!

- Investigating the use of rock art for girls’ initiation ceremonies in Southern Africa (Zubieta, 2006)
  - Why these paintings and not others?
  - Is distributed cognition useful to understand precisely how knowledge is transmitted?
Extending the “search space for solutions”

- Looking at the use of artifacts and the body
  - This is also where communication takes place!
  - Dynamical systems where explanations can be found

- Building the convention among a group:
  - 1-to-1 interactions are enough (Steels, 1996; Oudeyer, 2001)
  - Self-organization and emergence
  - Imitation and stabilization processes
Frontiers and bridges

The brain

The mind

The world

Archaeology
Psychology
Distributed cognition
Artificial intelligence
Ethology
Neurobiology
Semiotic approaches
Thank you for your attention