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Luc Steels, Dr.

Professor of Computer Science

Vrije Universiteit Brussel

Born in 1952 Belsele, Belgium

Studied Germanic Languages and Literature at the University of Antwerp and Computer Science at the Massachusetts Institute of Technology

FOCUS

PROJECT

The Origins of Language and Meaning@@@

My current research aims to conceive and validate a theory of the origins and evolution of language. This will only be possible if we have deep insight into all aspects of cognition that are involved in the invention and learning of language: We need to understand how embodied action is possible, how individuals can perceive the world and share world models even if they have different perspectives, how they categorize their world for language, how they represent vocabulary and grammar and use that in parsing and production. So we need to adopt a whole systems approach that cuts through all the boundaries currently dividing the cognitive sciences. We also need to understand the 'semiotic dynamics' that arises in groups of agents as they bootstrap progressively more complex communication systems. My project at the Wissenschaftskolleg will attempt to deepen and synthesize the experiments we have conducted so far and contribute to the focus group on Understanding the Brain.

Recommended Reading

Loreto, V. and L. Steels. 2007. "Emergence of language." Nature Physics 3, 11: 758-760.

Steels, L. and T. Belpaeme. 2005. "Coordinating perceptually grounded categories through language: a case study for colour." Target article. Behavioral and Brain Sciences 28, 4: 469-490.

Steels, L. 2003. "Evolving grounded communication for robots." Trends in Cognitive Science 7, 7: 308-312.

COLLOQUIUM, 12.05.2009

The Origins of Language -- Darwin's unsolved Mystery

Despite the enormous success of Darwin's theory of natural selection to explain the adaptation and origins of biological species, there is one gap, one nagging question, which remains largely unsolved. It is the question of the origins and evolution of language, something regarded by many as the capacity that makes us humans unique. Beautiful stories, myths, and speculations abound. But is it also possible to develop a scientific approach, compatible with what we know today about neurobiology, genetics, evolutionary biology, linguistics, cognition, and cultural evolution? Can we construct a clear, refutable theory and validate it using empirical observations, mathematical proofs and repeatable experiments? There is currently an intense debate raging between two opposing hypotheses.

(i) Either language has purely biological origins. It is just a special case of genetic evolution by natural selection. If this is true, we should expect there to be a highly specialized neuronal structure in the brain responsible for acquiring and using language and we should expect to find the language genes that shape this `language organ' during brain development. We can then work out a Darwinian scenario where success in symbolic communication impacts fitness and thus exerts positive selection pressure on these language genes.

(ii) But language could also have had socio-cultural origins. The human brain could have reached such a level of sophistication in our species that the necessary generic cognitive mechanisms were available to be recruited for building and exercising a symbolic communication system. Once a first rudimentary system got in place, cultural evolution would have kicked in, supporting the further transmission and cumulative growth of language complexity.

In my laboratory, we have been trying to work out and validate the latter socio-cultural scenario. We are taking an unusually daring route. Because we are dealing with incredibly complex phenomena that defy direct observation, we focus on building models. And to make these models testable, we embody them in artificial agents, in other words in physical humanoid robots. Our experiments typically focus on a particular phenomenon in language, such as color terms, tense and aspect, action verbs, determiners, spatial prepositions, case marking or clause subordination, and we try to explain how this could have evolved by setting up an experiment in which the phenomenon emerges from the interactions between the robots.

As a first step, we reverse engineer all the capacities robots need to play situated language games about the physical world using an existing natural system, for example color terms in Spanish or aspect marking in Russian. These capacities not only require mechanisms for conceptualizing the world, for interpreting meanings, and for parsing and producing the lexical and grammatical structures underlying utterances, but also the necessary motor behaviors and perceptual processes needed to physically play the language game. Next we reverse engineer the learning, invention, and alignment strategies that could have given rise to such a natural system and then show that robots endowed with these strategies are indeed able to autonomously self-organize their own artificial language systems with similar properties as those found in human languages. For example, we show how robots are able to invent and coordinate a grammatical system to express the roles of participants in the events they see before them.

In this talk, I give a few examples of successful experiments and then outline the theory of language evolution by linguistic selection which has come out of them. It turns out that many fundamental concepts of evolutionary biology, such as variation, competition, selection, exaptation, fitness, etc., can all be transposed to the domain of cultural language evolution. Linguistic selection is driven by the maximization of communicative success and the minimization of cognitive effort. It selects out of the unavoidable variation among linguistic constructions and meanings circulating in a population the ones that are most adapted to the communicative challenges the population faces. The final answer to the question how languages originated and evolved cannot be given yet, but at least we now have a solid methodology for investigating certain aspects of it.

Steels, Luc (New York, NY,2017)

Human language is a culturally evolving system

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1794169490

Steels, Luc (Amsterdam,2017)

Basics of fluid construction grammar

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1794167463

Steels, Luc (Amsterdam,2016)

A boy named Sue

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1794168370

Steels, Luc (London,2016)

Agent-based models for the emergence and evolution of grammar

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Steels, Luc (2016)

Do languages evolve or merely change?

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1048671399

Steels, Luc (Berlin, New York, NY,2016)

Fluid construction grammar as a biological system

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=1048654001

Steels, Luc (Washington, DC,2015)

Music learning with massive open online courses (MOOCs)

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=848713346

The future of learning ; v. 6

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=848713346

Steels, Luc (Berlin,2015)

The Talking Heads experiment : origins of words and meanings

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=836668561

Computational models of language evolution ; 1

https://kxp.k10plus.de/DB=9.663/PPNSET?PPN=836668561

Steels, Luc (New York [u.a.],2012)

Grounding language through evolutonary language games

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Steels, Luc (Berlin,2012)

Computational issues in fluid construction grammar : a new formalism for the representation of lexicons and grammars

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Lecture notes in computer science ; 7249

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