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FOCUS

### PROJECT

## Solving the Riddle of Language Evolution

My Wiko project attempts to synthesize my work on language evolution over the past decade and to capture it in a monograph. I will focus specifically on the cultural evolution of complex grammar. The key idea is to generalize the well-known Darwinian framework, which has been enormously productive in evolutionary biology, and apply it to cultural language evolution. This framework suggests that we need to identify the units of evolution and find analogues for heredity, variability and selection. Once these ingredients are in place, a spiralling, ever-expanding complex adaptive system gets established. What are these analogues?

Many linguists have argued that the fundamental unit of language is the construction, a pairing of meaning and form through the intermediary of syntactic and semantic categorisations. I therefore propose that this is the unit of linguistic evolution. Heredity means then that constructions must be preserved and diffuse. At the individual level, constructions are preserved because speakers and hearers store them in their private construction memories. At the group level, constructions propagate through social learning. Variation is unavoidable, partly because learning grammatical constructions is not a copying process (rather, the learner has to formulate hypotheses based on partial evidence) and partly because speakers are creative: they regularly need to stretch existing constructions to satisfy new purposes or coerce words into novel usages. Constructions compete. The main selection criteria are communicative success and reduction of cognitive effort.

With my group, I have already been carrying out plenty of simulation experiments to model language emergence and cultural evolution within this framework, focusing on the origins of colour terms, action words, spatial language, grammatical agreement, phrase structure grammars and so on. It will be an enormous challenge to capture all this work in a single monograph, but the time is ripe for it and Wiko is the unique place that can make this project a reality.

### Recommended Reading

Steels, Luc, ed. (2012). *Experiments in Cultural Language Evolution*. John Benjamins, Amsterdam.

Beuls, Katrien and Luc Steels (2013). "Agent-based models of strategies for the emergence and evolution of grammatical agreement." *PLOS ONE* 8, 3: e58960. doi:10.1371/journal.pone.0058960

Steels, Luc (2011). "Modelling the cultural evolution of language." *Physics of Life Reviews* 8, 4: 339-356.

[www.sciencedirect.com/science/journal/15710645/8](http://www.sciencedirect.com/science/journal/15710645/8).

## How Language Creates Humans

The question how human language has originated and how it evolves remains one of the deepest unsolved problems of science despite having recently become a hot topic in many disciplines (particularly biology, anthropology, psychology, linguistics and philosophy). The question is profoundly important because language has made our species unique. It is at the same time extraordinarily mysterious and difficult to address using scientific methods because we have no fossils for the earliest phases of language, we cannot (yet) peer into the human brain to see how language is processed and learned, and we cannot monitor the linguistic activities of whole language communities to see how their languages change over time. This makes language evolution a more difficult subject for science than the origin of the cosmos or the origin and evolution of life.

This talk introduces my own work on this topic. It is strongly inspired by the theoretical framework of evolutionary biology and makes extensive use of methods from computer science, in particular agent-based modeling, in order to derive possible causal and mechanistic theories regarding the emergence of language and validate these theories through systematic experiments, some using robotic humanoid agents. (Video clips of these will be shown in the talk.)

I pursue two main hypotheses: (i) Language is a "living" complex adaptive system that emerges and evolves through a process of cultural evolution. (ii) This cultural evolution process is cyclical and endless. Meanings that are implicit and must be inferred by listeners may become explicitly expressed through words, syntactic patterns, or morphological paradigms. But expressions may erode again when words lose syllables due to phonetic simplification, when syntactic patterns lose components due to routinization, and when morphological markers level off. Thus the expression of certain meanings may become lost and has to be inferred from the context or remainder of the utterance, after which new forms of expression may re-emerge.

The key question I address in my research is: What are the cognitive mechanisms and social interaction patterns that enable this extraordinary cyclical process of language creativity? What are the collective dynamics that allow a language to emerge and remain shared despite profound variation and endless change? I will illustrate the unexpected progress we have made on these questions in the past decade using some astounding experiments on how vowels can emerge, how a vocabulary of color and action words can originate in a population and adapt to changing needs, how syntactic patterns may form and give rise to sophisticated grammar, and how morphologies for expressing cases may originate and erode and collapse again.

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PUBLICATIONS FROM THE FELLOWS' LIBRARY

Steels, Luc (New York, NY,2017)

Human language is a culturally evolving system

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=1794169490>

Steels, Luc (Amsterdam,2017)

Basics of fluid construction grammar

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=1794167463>

Steels, Luc (Amsterdam,2016)

A boy named Sue

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=1794168370>

Steels, Luc (London,2016)

Agent-based models for the emergence and evolution of grammar

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=169026862X>

Steels, Luc (2016)

Do languages evolve or merely change?

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=1048671399>

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

Fluid construction grammar as a biological system

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=1048654001>

Steels, Luc (Washington, DC,2015)

Music learning with massive open online courses (MOOCs)

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=848713346>

The future of learning ; v. 6

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=848713346>

Steels, Luc (Berlin,2015)

The Talking Heads experiment : origins of words and meanings

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Computational models of language evolution ; 1

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=836668561>

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

Grounding language through evolutionary language games

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=1690083506>

Steels, Luc (Berlin,2012)

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

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=726153001>

Lecture notes in computer science ; 7249

<https://kxp.k1oplus.de/DB=9.663/PPNSET?PPN=726153001>