THE WIKO REVISITED

LUC STEELS

Luc Steels studied linguistics at the University of Antwerp (Belgium) and computer science at the Massachusetts Institute of Technology (USA). His main research field is Artificial Intelligence covering a wide range of intelligent abilities, including vision, robotic behavior, conceptual representations and language. In 1983 he became a professor of computer science at the University of Brussels (VUB). He has been co-founder and chairman (from 1990 until 1995) of the VUB Computer Science Department. He founded the Sony Computer Science Laboratory in Paris in 1996 and became its first director. Currently he is ICREA research professor at the Institute for Evolutionary Biology (CSIC, UPF). Steels has produced over 200 articles and edited 15 books directly related to his research. During the past decade he has focused on theories for the origins and evolution of language using computer simulations and robotic experiments to discover and test them. – Address: AI Laboratorium – 1OG720, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium. E-mail: steels@arti.vub.ac.be.

My stay at the Wiko was a wonderful and highly productive experience. I admit, it was my second time, which means that I already knew how the system worked. I knew the amazing efficiency and friendliness of the Wiko staff, the incredible wonders of Berlin, and the deep friendships that are created at the Wiko. I also knew that the Wiko creates optimal conditions for profound thinking and productive writing. But I also knew that the time goes enormously quickly and Fellows seldom entirely finish the projects they plan. This second time, I was determined to focus with the highest possible energy on my scientific work, shaping my thinking on the evolution of language into a more coherent

framework, devising new experiments that would keep my team focused over the coming decade, and above all attempting to write a book for a broader audience.

The Focus Group on Language Evolution

I was the leader of a Focus Group on language evolution that included Peter Gärdenfors (Lund University), Holger Diessel (University of Jena), Dorit Bar-On (University of Connecticut), and Susan Goldin-Meadow (University of Chicago), who unfortunately had to pull out at the last minute due to sad events in her family. Even though there is more than a century of work in historical linguistics, with an important tradition in Berlin during the 19th century, research into language evolution is a relatively new, still very controversial field. It wants to understand how the language faculty could have evolved given currently accepted theories in evolutionary biology, and how human languages can originate, spread, collapse, or continuously change in a process of cultural evolution. These two topics are highly interrelated because cultural change is canalized by the biologically given language faculty and by auditory and cognitive capacities, and this language faculty is itself shaped and reshaped by the need to sustain the process of the origins, transmission, and usage of language.

Language is an extraordinarily complex system that requires the utmost from the human brain. But it is also a social phenomenon in which a very large collection of individuals without any central organization or mutual telepathy among its members can somehow invent and share conventions for expressing rich, open-ended meanings. Given this complexity, many different fields have taken a stake in language evolution research: archaeologists and anthropologists, ethologists, philosophers of language, psycholinguists, neurolinguists and historical linguists, social scientists, computer scientists, complex systems researchers, and a growing group of theoretical linguists, for whom the topic of language evolution was not central to their preoccupations in the 20th and early 21th century. At this point, there is no generally agreed-upon theory of language evolution, and there is not even a consensus on what such a theory would look like. Even the fundamental hypothesis that human languages exhibit true cultural evolution is being debated intensely.

The Focus Group was designed to cover significant ground within this complex research landscape by bringing in multiple perspectives. My own perspective is that of the computational linguist. I have training both in linguistics and in computer science and

have worked for decades building very sophisticated models of many aspects of cognition, from visual perception, through audition and motor behavior, to knowledge representation, reasoning, and language processing. About two decades ago, I decided to pull all my background and skill together and make operational models of language evolution in the form of "linguistic agents" that interact with each other in consecutive series of language games and that autonomously build up and share an artificial communication system with properties similar to those found in human natural languages. This methodology, adopted from similar "agent-based" simulations commonly developed in biology and sociology (illustrated, for example, by the prisoner's dilemma game) is a reproducible, objective way to test scientific proposals for language evolution. Although many experiments have since been set up (see Steels 2015) and, in my opinion, very significant progress has been made, the methodology is not yet understood and hence not yet accepted or practiced widely by the language evolution community, undoubtedly because it requires very sophisticated computational skills to put to work.

Peter Gärdenfors came on board as the semanticist. His work on "conceptual spaces", a broad framework for modeling human cognitive semantics using concepts gleaned from geometry, is well known and has played a key role in several of our language evolution experiments. Peter is also keenly interested in more fundamental questions about the origins of symbols and the historical evolution of our species in relation to the emergence of language. Susan Goldin-Meadow had the role of the psycholinguist. She has done ground-breaking work on the origins of gestural communication, particularly in deaf communities. Holger Diessel was our expert grammarian. He is a well-known authority in usage-based linguistics and construction grammar, which is a particular way of describing and formalizing language that supports better empirical data on child language learning and cultural language change. Finally, Dorit Bar-On represented the viewpoint of the philosopher of language. She brought not only her encyclopedic knowledge of the debates in that field, but also her philosophical scalpel, which was helpful to critically examine and sharpen the arguments and conceptual frameworks we are trying to develop.

To say that the Focus Group played a big role in my work at the Wiko is an understatement. We gave each other almost daily advice and encouragement, exchanged well-meant but nevertheless very sharp comments, went out together, played together in our band at the *Abschiedsfest*, and in general became very good friends for life. There are still plans for a joint paper that is still in the pipeline.

The Workshops

We decided early on that our Focus Group would work by having regular lunch discussions, a weekly journal club where we read each other's work and relevant work of other scholars, and a series of "salons", open to all members of the Wiko, that would cover the *four key areas* in language evolution research that coincided with the interests of the different members of the Focus Group: (i) The origins of symbolic gestures, (ii) the origins and evolution of semantics, (iii) the origins of communication, particularly in relation to animal communication, and (iv) the origins and evolution of grammar.

On that basis four workshops were organised, which were of tremendous importance, partly because they allowed the presentation of the emerging views to a critical small audience, but also because they helped to push our individual research agendas significantly forward. We are very grateful to Wiko for financial support and to Vera Kempa, whose capable organizational help was crucial. It is worthwhile to discuss the contents of these workshops in some detail.

(i) *Origins of Symbolic Gesture* (October 19–20, 2015). Many scholars believe that gestural communication may have preceded language, basing their arguments on observations of child language acquisition, in which symbolic gestures clearly precede verbal communication, and ethological observations of non-human primates. The goal of this first "salon" was to discuss concrete scenarios (such as ontogenetic ritualization) for the origins of symbolic gesture in animals, robots, and humans, from the viewpoints of neurobiology, cognitive science, and language. The different attendants came from very different perspectives, ranging among neurobiology, animal communication, robotic modeling of sensorimotor behavior and gesture, and language.

This workshop had contributions by Michael Arbib (University of Southern California) on "How communication emerges from action: A dyadic brain model of ape ontogenetic ritualization as related to the gestural origins of the human brain's readiness for language", Federico Rossano (University of San Diego) and Katja Liebal (Freie Universität Berlin) on "Origins of animal and infant symbolic gesture", Manfred Hild (Beuth Hochschule für Technik Berlin) and Luc Steels (Fellow) on "Robotic models for symbolic gesture and its origins", Holger Diessel (Fellow) on "Demonstratives", Peter Gärdenfors (Fellow) on "Coevolution of cognition, cooperation and communication", and Dorit

Bar-On (Fellow) and Richard Moore (Berlin School of Mind and Brain) on "Philosophical issues and conclusions".

(ii) *The Evolution of Meaning*. Most theories of language evolution focus on the evolution of linguistic form. But before there are words, there must be meanings to communicate. This raises questions about conceptualization, deciding what to say, and interpretation, which means using semantic structures obtained from parsing an utterance to make sense of what the speaker intends. Concretely, we need to answer the question how the conceptual building blocks required for conceptualization originate and become shared in the population in interaction with an emergent language. The workshop discussed the evolution of semantics, the relations between language and culture, and the relation between linguistic meaning and other forms of meaning. Also, problems related to how meanings develop in children and how the evolution of meaning can be modeled and simulated in artificial systems were intensely debated.

The workshop had contributions by Peter Gärdenfors on "The evolution of semantics to achieve shared conceptual domains", Merlin Donald (Swedish Collegium for Advanced Study, Uppsala) on "Meaning evolved in the representational interface between brain and culture", Michael Tomasello (Max Planck Institute for Evolutionary Anthropology, Leipzig) on "Communication without conventions", Luc Steels (Fellow) on "Grounded evolutionary semantics", Gerhard Jäger (Universität Tübingen) on "The phylogeny of word meanings: Inferring the directionality of semantic change from word lists", Dorit Bar-On (Fellow) on "Expression, communication, and origins of meaning: A philosophical perspective", and Massimo Warglien (Università Ca'Foscari, Venice) on "Projective games: Partial representations, cultural evolution and meaning". Manfred Bierwisch (Fellow 1991/1992 and member of the former Akademie der Wissenschaften der DDR, Berlin) also participated in the discussions.

(iii) *Rethinking Animal Minds and Meanings: Toward an Interdisciplinary Understanding of Nonlinguistic Thought and Communication* (May 12–13, 2016). Recent decades have seen important changes in the way we understand animal communication. The view that animal signals consisted essentially of affective, reflex-like stimuli and responses was replaced by a view of animal communication as flexible and considerably "cognitive". Primates and other species demonstrated apparent referential understanding of vocal signals, and studies with apes suggested communicative intentionality in their use of gestures.

However, it was never clear what sort of knowledge and understanding of reference and intentionality was being attributed to animals, and recent years have seen attempts at revisiting the initial interpretations. What sort of meaning is animal meaning? Hasn't the cognitive side of animal signals been exaggerated at the expense of the affective and emotional sides? Is affective/emotional communication necessarily less complex and non-referential? And what is the relation between animal communication and human language evolution? This interdisciplinary workshop explored ways of rethinking animal meaning and communication in the wider context of rethinking our understanding of the minds of nonverbal creatures.

The workshop had contributions by Juan-Carlos Gomez, Derek Ball, Verena Kersken, and Amanda Seed (University of St. Andrews), followed by contributions from Klaus Zuberbühler (Fellow 2009/2010, Université de Neuchâtel and University of St. Andrews) on "Vocal communication in primates: Is there really reference and intention?", Julia Fischer (German Primate Center, Göttingen) on "What does it all mean? Revisiting the alarm calls of vervet monkeys", Cat Hobaiter (University of St. Andrews) on "Without words: Investigating meaning in great ape gesture", Ulf Liszkowski (Universität Hamburg) on "Complexities and origins of prelinguistic communication", Peter Gärdenfors (Fellow) and Anders Högberg (Uppsala University) on "Under the evolution of teaching", Manuel Bohn and Josep Call (Max Planck Institute for Evolutionary Anthropology, Leipzig) on "Non-linguistic reference to absent entities", and Dorit Bar-On (Fellow) and Richard Moore (Berlin School of Mind and Brain) on "Pragmatic interpretation, signaler-receiver asymmetries, and the evolution of language". This workshop was co-organized with Juan-Carlos Gomez (University of St. Andrews) and partly funded by the University of St. Andrews through the AHRC Science in Culture Project "Rethinking Mind and Meaning".

(iv) *Mechanisms of Grammatical Change* (June 2–3, 2016). Traditionally, grammatical representations are analyzed in terms of a few primitive categories and combinatorial rules that are (largely) independent of usage and development; but there is now a large body of research arguing that linguistic structure is emergent and that grammar should be analyzed as a dynamic system consisting of fluid categories and flexible constraints that are shaped by general cognitive processes. It was the purpose of this workshop to explore the mechanisms that "drive" the emergence of linguistic structure in the process of diachronic language change. Grammatical phenomena to be investigated include (for instance) the

emergence of grammatical markers and constructions, the development of morphological paradigms and syntactic categories, the interaction between lexemes and constructions over time, and change in word order. We will explore these phenomena in light of general cognitive processes such as conceptualization (i.e., the cognitive structuring of experience and the way this affects semantically driven grammatical change), analogy and structural priming (i.e., the mapping of relations across categories and construction and its effect on the development of linguistic paradigms), automatization and chunking (i.e., the rise of linguistic sequences and the weakening or loss of linguistic structure), the flow of consciousness (i.e., the constantly moving focus of attention in the unfolding stream of speech and the consequences this has for the organization and development of linguistic units), and, of course, social interaction (i.e., cognitive processes that concern the coordination of the language users' shared knowledge and the way this influences the "packaging" of information in language use and language development).

The workshop had contributions by Martin Haspelmath (Max Planck Institute for the Science of Human History, Jena) on "Grammatical change and grammatical universals", Luc Steels (Fellow) on "Can we build agent-based models for the complete grammar cycle? And what would we learn from that?", Martin Hilpert (Université de Neuchâtel) on "Asymmetric priming as a mechanism of grammatical development", Katrien Beuls (Vrije Universiteit Brussel) on "Simulating resemanticization processes in Dutch pronominal gender agreement", Freek Van de Velde (University of Leuven) on "Language change is a function of historical demography", Sonia Cristofaro (Università di Pavia) on "Grammatical change and the emergence of recurrent cross-linguistic patterns", Remi van Trijp (Sony Computer Science Lab Paris) on "Transparency vs. processing efficiency: A case study on German declension", and Holger Diessel (Fellow) on "Word order correlations: Grammaticalization, nominalization, and analogy".

These workshops together painted a rich tapestry of ideas, viewpoints, experiments, and observations that are relevant for understanding language evolution. No clear framework has emerged yet and each discipline, naturally, seeks its own type of explanation. Personally, I felt that the final workshop (on grammatical change) held the highest promise. Although historical linguists do not consider themselves to be working on language evolution and are weary of computer simulations of any kind, it is clear to me that they have amassed the empirical foundations necessary to tackle and ground research in the causal mechanisms that explain the remarkable change in human languages. These mechanisms include the cognitive mechanisms available to the human mind, the social

dynamics of human populations, and the cultural and economic contexts that generate the expressive demands on language. Understanding the cognitive mechanisms required for the usage, acquisition, and innovation of language give us clues to the nature of the language faculty and put us on a path to understanding how these mechanisms are implemented in human neurobiology and could have evolved through biological evolution.

My Life at the Wiko

There is a pattern. Fellows arrive like young children at a new boarding school. They discover a new wonderful world far away from the daily, often silly pressures that beset academics, particularly in experimental fields like my own, which require the maintenance of a technical group and hence never-ending writing of proposals and dealing with annoying accounting issues, uncooperative reviewers, students, departmental fights for resources, etc. A Fellow's first months are typically spent settling into new daily routines, cleaning up old work, and finishing papers that were half-written or not yet completely published. At the same time, preliminary work on the book project starts with collecting materials, venturing out in neighboring fields, and discussing ideas with other Fellows.

This is also what happened for me. I did not attack my book project right away, but first finished some publications (in particular Steels 2016a, b and Steels et al. 2016) and wrote a few commentaries and discussion notes, often as a reaction to discussions with other members of the Focus Group or workshop discussions. One of these had the unusual title "I'm gonna have to science the shit out of this" and was published in the *Physics of Life Journal* (Steels 2016a). It analyzes a famous sentence uttered by Matt Damon in the film "The Martian" and illustrates nicely the creative grammaticalization processes that underlie language change: the noun "science" has become recruited as a verb, "the shit out of", which is a noun phrase, has become a modifier of "this", and "I'm gonna" illustrates how an expression "I am going to X" was recruited for the expression of future. The auxiliary "am" became compacted and eroded into an affix of the subject and "going to" compacted into "gonna". Moreover, there is further evidence from language use data that "gonna" is beginning to behave like an auxiliary, as in "You gonna make this meeting?" The discussion note then goes on in response to the talk that Michael Arbib gave at the first colloquium, arguing that the human capacity to handle unusual and creative language use must be an essential component of any model of language. It requires a kind of meta-level on which diagnostics are triggered (such as the use of a noun where a verb is

expected) and repairs are enacted to resolve flagged issues (such as coercing the noun to act as a verb).

I also started writing some sections and ideas for the first chapters of my book. None of them turned out to be a sufficiently productive track, even though they provided material for other (subsequently published) discussion notes arguing that a human language is an evolutionary system in its own right (see Steels 2016c and 2016d). The most important paper I wrote and revised as my Wiko stay unfolded was for the *Philosophical Transactions of the Royal Society B* (Steels 2016e). It sketches a general framework for studying cultural language evolution, makes a link to historical linguistics, and introduces the methodology of agent-based modeling. This paper profited greatly from discussions with other members of the Focus Group, who read and commented on earlier drafts.

The beginning of January is a turning point for many Fellows. The honeymoon period is over. The days get darker and shorter. Ferocious winds are blowing and rain is streaming down. After the Christmas holiday, many Fellows realize that they cannot keep wandering around in the candy store of science, writing papers, reading, and discussing all the other fascinating topics that other Fellows bring to the Wiko. They realize that they have to focus more on their project if they want to succeed.

This happened also to me. I retracted almost completely to my office for writing and thinking. I renounced all the great musical, theatrical, and operatic performances happening in Berlin and only took time off for bicycle rides in Grunewald, which remained possible all year thanks to an exceptionally mild winter. I also admit that I had to scale down my social interactions with the other Fellows, maintaining participation in lunches and Tuesday colloquia, of course, but sadly renouncing the weekly Monday morning walks, late night parties, and other social occasions. However, this paid off.

Ideas began to flow. I hit upon a key literary device that would help to organize the whole book, namely to view research into language origins as climbing a treacherous mountain. I imagined this mountain to be in the Pyrenees, namely the Pico de la Maladeta. Although I never visited this region, I found enough geographic and tourist information, as well as information for mountain climbers, on the web to see the beginning of a fascinating story, in which other mountaineering teams represented other groups doing language evolution research. Instead of a dry scientific treatise, alternative views and debates could be represented as dialogs between the key protagonists who were all trying to climb the mountain. By April, I had the first five chapters and hesitantly showed it to the other members of our Focus Group. (Actually, if Peter Gärdenfors had not forced me, I would

not have dared to do it.) To my relief, they were all enthusiastic and encouraged me greatly. I want to stress here the importance of the Wiko in this respect. Fellows help each other. Particularly experienced writers help novices, and this support is essential to keep up the stamina and concentration and not fall prey to the inevitable states of depression when things are not moving forward at all.

In May, there is another change in the dynamics of the Wiko community, possibly triggered by a marked improvement in the weather. You have one group that has more or less given up on finishing their book projects. They concentrate instead on building a stronger network with other Fellows and other research groups in Berlin. They have clearly decided to fully enjoy the cultural richness of the city and the great natural environment of Grunewald. There is another group that digs in deeper and works with greater dedication to try to reach enough momentum so that their book project, even though it will not get finished, will at least continue to roll on during the summer and beyond. I was a member of the second group, still hoping to make more headway with my book. But sadly, I had to switch gears to work on proposals.

A year without proposal writing would mean the end of my research group and so I had to start responding to calls. Writing a proposal, particularly for European grants, is a big undertaking that requires forming a consortium and constructing a 70-page document with a fully elaborated work plan and budget. The chances that the proposal will be accepted are small. For the calls relevant to my topic, they are close to 1 %, but still, the best researchers in the field compete because there are few alternatives. During the month of May, I participated in two consortia. They were both application-oriented. The first one used the computational construction grammar formalism that I developed with my team for applications in tutoring – we were particularly interested in building apps that immigrants could use to acquire the local language of the community they live in. The second one, equally important from a societal point of view, used our grammar formalism to analyze texts on social media with the explicit goal of mapping belief dynamics on contentious issues such as climate change, immigration, or Brexit. Both proposals were submitted, and I am happy to report that the second one was accepted. This was without a doubt due to the total concentration that I could manage while being at the Wiko.

As the final months set in, I kept working on my book project and even got an important publisher interested, but also spent considerable time preparing my Tuesday colloquium, which was the last one in the series at the end of June.

When I look back, I am happy to have had a very productive period of thinking and writing. I laid the foundation for the future work of my group both financially and in terms of clear guidance about which experiments we should now do. I certainly spent less time enjoying Berlin (although I did see a fair share of operas, including Wagner's full *Ring* at the Staatsoper) and less time with other Fellows than I would have liked. It is clear to me that the Wiko plays a tremendously important role in the advancement of science. I can testify to this with respect to my own work, but I see it also for other Fellows. My gratitude to all those who make this opportunity a reality is indescribable.

References

Steels, Luc (2015). "The talking heads experiment: The origins of words and meanings. Series: Computational Models of Language Evolution (1)." Language Science Press, Berlin. Open access through: http://langsci-press.org/catalog/book/49.

Steels, Luc (2016a). "Meaning and creativity in language." In: M. Esposti, E. Altmann and F. Pachet (eds.) *Creativity and Universality in Language*. Springer Verlag, Berlin. pp. 197–208.

Steels, Luc, M. Loetzsch, M. Spranger (2016). "A boy named Sue: The semiotic dynamics of naming and identity." *Belgian Journal of Linguistics* vol. 30.

Steels, Luc (2016a). "Basics of fluid construction grammar: Constructions and frames." (in review).

Steels, Luc (2016b). "I'm gonna have to science the shit out of this." *Physics of Life Reviews* PLREV720. doi: 10.1016/j.plrev.2016.02.002.

Steels, Luc (2016c). "Human language is a culturally evolving system." *Psychonomic Bulletin and Review* 23(4). doi: 10.3758/s13423-016-1086-6.

Steels, Luc (2016d). "Language evolution or language change?" *Journal of Neurolinguistics* (in press).

Steels, Luc (2016e). "Agent-based models for the emergence and evolution of grammar." *Phil. Trans. R. Soc. B* 371: 20150447. doi: 10.1098/rstb.2015.0447.