COGNITIVE MORPHODYNAMICS

Dynamical Morphological Models of Constituency in Perception and Syntax

Jean PETITOT

In collaboration with René DOURSAT

Grammatically specified structuring appears to be similar, in certain of its characteristics and functions, to the structuring in other cognitive domains, notably that of visual perception.

Len Talmy

By the same author

- *Les Catastrophes de la Parole. De Roman Jakobson à René Thom.* Paris: Maloine,1985.
- *Morphogenesis of Meaning.* Bern: Peter Lang, 2004.
- *Physique du Sens.* Paris: Editions du CNRS, 1992.
- *Neurogéométrie de la vision. Modèles mathématiques et physiques des architectures fonctionnelles.* Paris: Les Éditions de l'École Polytechnique, Distribution Ellipses, 2008.

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- (ed., with F. Varela, J.-M. Roy & B. Pachoud) *Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science*, Stanford University Press, 1999.
- (ed.) "Linguistique cognitive et Modèles Dynamiques", *Sémiotiques*, 6-7, 1995.
- (ed. with J. Lorenceau) "Neurogeometry and Visual Perception", *Journal of Physiology – Paris*, 97, 2003.
- (ed. with A. Sarti & G. Citti) "Neuromathematics of vision", *Journal of Physiology – Paris*, 103, 2009.

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Contents

Cognitive grammars have defended the view that the deep syntactic and semantic structures of language, such as prepositions and case roles, are grounded in perception and action—and more generally in human cognitive abilities. This alternative "anchored" linguistics was devised in opposition to the formal and generative conceptions of syntax. In turn, however, it raises crucial questions and difficult problems, which have been addressed thus far mostly from a descriptive and philosophical perspective, but not as a mathematical challenge.

Building on this background, the purpose of this book is to provide cognitive grammars with a rigorous, operational *mathematical* foundation, which draws from topology, geometry and dynamical systems to model iconic "image-schemas" and "conceptual archetypes". Based on a review and synthesis of a body of research spanning the past three decades, we defend the thesis that René Thom's *morphodynamics* is especially well suited to the task. It allows to transform the morphological structures of perception into Gestalt-like invariant, abstract schemas that can act as inputs into higher-level specific linguistic routines. Following "bottom-up" direction, the aim of morphodynamics is to bridge the lingering gap between perception and action, on the one hand, and the *proto*-linguistic structures underlying natural languages, on the other.

Jean Petitot is a mathematician and expert on neurocognitive models, a semiolinguist and a philosopher of science. He is currently professor at the École des Hautes Études en Sciences Sociales (EHESS) in Paris, and former director of CREA, the research center in applied epistemology (focusing on cognitive science and self-organization) of École Polytechnique, Paris. He is the author of eight books and over 300 articles, the editor of 10 volumes, and a member of the International Academy of Philosophy of Science, the editorial boards of several journals, and the scientific committees of many institutions. Since his pioneering work of the late 1970s, he has become a leading specialist of morphodynamical models in computational neuroscience, cognitive semiolinguistics and phenomenology.

René Doursat is director of the Complex Systems Institute, Paris Ile-de-France (ISC PIF), and a researcher at CREA. Previously, he was a visiting professor in computer science at the University of Nevada. His research activities address the agent-based modeling and simulation of large developmental and neural systems, which are aimed at a new form of bio-inspired artificial design called *Morphogenetic Engineering* (edited book forthcoming).