The Structural Design of Language

Although there have been numerous investigations of biolinguistics within the Minimalist Program over the last ten years, many of which appeal to the importance of Turing's Thesis (that the structural design of systems must obey physical and mathematical laws), these studies have by and large ignored the question of the structural design of language. They have paid significant attention to identifying the components of language – settling on a lexicon, a computational system, a sensorimotor performance system, and a conceptual-intentional performance system; however, they have not examined how these components must be inter-structured to meet thresholds of simplicity, generality, naturalness, and beauty, as well as of biological and conceptual necessity. In this book, Stroik and Putnam take on Turing's challenge. They argue that the narrow syntax – the lexicon, the Numeration, and the computational system – must reside, for reasons of conceptual necessity, within the performance systems. As simple as this novel design is, it provides, as Stroik and Putnam demonstrate, radical new insights into what the human language faculty is, how language emerged in the species, and how language is acquired by children.

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Cambridge University Press
978-1-107-03483-9 - The Structural Design of Language
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CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Mexico City

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9781107034839

First published 2013

Printed and bound in the United Kingdom by the MPG Books Group

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication data
Stroik, Thomas S.
The structural design of language / Thomas S. Stroik, Michael T. Putnam.
pages cm
Includes bibliographical references.
ISBN 978-1-107-03483-9
1. Grammar, Comparative and general – Syntax. 2. Generative grammar.
3. Minimalist theory (Linguistics) 4. Biolinguistics. I. Putnam, Michael T.
II. Title.
P291.S693 2013
415–dc23
2012034002

ISBN 978-1-107-03483-9 Hardback

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Preface

Discovery commences with the awareness of anomaly, i.e., with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science. It then continues with a more or less extended exploration of the area of anomaly. And it closes only when the paradigm theory has been adjusted so that the anomalous has become the expected.

Thomas S. Kuhn, *The Structure of Scientific Revolutions* (1962: 52–53)

We would like to begin our book with a somewhat startling observation: theories of generative grammar and theories of modern physics appear to exhibit similar anomalies involving putative violations of the Principle of Locality. In physics, both gravity and quantum particle entanglements have been analyzed, at one time or another, as processes that allow action at a distance, in violation of the Principle of Locality, which requires all physical processes to be immediate and immanent. And in generative grammar, displacement phenomena, such as *Who does Sam think that Jesse believes that Chris expects Pat to talk to __ tomorrow* (where the prepositional object *who* has been separated from its preposition), have been explained in terms of long-distance grammatical operations that connect a displaced constituent to its displacement site – operations that violate the Principle of Locality by allowing action at a distance.

We find the fact that generative grammar and modern physics are investigating similar questions about (non-)locality to be particularly interesting because it raises the possibility that we will be able to gain some valuable insight into how to analyze locality in grammar by looking at how work in physics has dealt with locality. So let us consider what we can learn about locality from physics. Locality issues in physics go at least as far back as Newton. In his Law of Gravity, Newton formulates gravity to be an instantaneous force that acts on bodies at any distance. Newton's Law of Gravity, then, is a non-local law. Despite the explanatory successes of Newton's theory of gravity, Einstein, committed to local realism, rejected Newton's analysis of gravity on conceptual grounds. As Einstein proves in his Special Theory of Relativity, no information can be transmitted faster than the speed of light; as a result, no force (including the force of gravity) can be an instantaneous force acting at a distance. Therefore, Newton's Law of Gravity must be wrong. Although the Special

Theory of Relativity undermines Newton's theory of gravity, it does not replace Newton's non-local theory with a local theory of gravity. The reason it does not do so is that the Special Theory of Relativity, even though it adds a fourth (time) dimension to physical laws, does not re-conceptualize Newton's three spatial dimensions. As a consequence, the non-local spatial relations that stand at the heart of Newton's Law of Gravity remain the same in the Special Theory of Relativity, which leaves the latter theory unable to provide an alternative explanation for gravity. To give a non-local account of gravity, Einstein had to re-conceptualize not just the laws involved in transmitting information, but the nature/structure of space and time. In his General Theory of Relativity, Einstein shows that space and time are not flat, as they are for Newton; rather, space-time is locally curved by whatever mass is present. For Einstein, gravitational effects do not arise from an attraction-force acting at a distance, but from the local curvature of space-time. What is important to point out about Einstein's re-analysis of Newton's non-local theory of gravity is that this analysis required more than reformulating the laws that explain how information is transmitted in space and time, it required a radical redesign of the structure of space and time itself.

A similar story can be told about quantum entanglements, in which two particles that intersect continue to be informationally connected no matter how far apart they become positioned. Of note, this informational alignment (in terms of physical properties such as momentum, spin, polarization, etc.) is non-local and instantaneous; hence, it appears to violate the light-speed limit on the transmission of information. Einstein (once again the champion of the Principle of Locality) took exception to quantum entanglement, calling it "spooky action at a distance." Even though Einstein and others sought to give a local explanation for quantum entanglement by introducing "hidden variables" into quantum equations, these maneuvers have failed. Some promising, local solutions to the non-locality of entanglements, however, have been advanced recently. These solutions, it is interesting to note, come from string theory/M-theory and from multiverse theories; that is, the solutions are grounded in radical re-conceptualizations of space and time. At present, it is not clear whether or not any of the proposed analyses of quantum entanglements will eventually succeed in giving a local explanation for entanglement; what is clear, though, is that if there are to be local solutions to quantum particle entanglement, they will have to be structure-based (a Turing solution) and not rule-based (a Galileo solution). That is, obviating non-local anomalies in a given physical domain cannot be done by reconfiguring the laws or principles that operate within the domain; it requires, instead, reconfiguring the domain because the anomalies are in the domain (not of the domain).

As we note above, generative grammar is like modern physics in that it seems to permit non-local processes. Although it has been recognized by generative theorists since Ross (1967) that non-local grammatical processes are problematic because they overgenerate syntactic structures, solving this problem has been approached largely as a computational problem in need of a Galileo-type solution. Hornstein (2009: vii) makes this poignantly clear when he states,

> Thus, Chomsky (1977) assumed that Ross's (1967) constraints were more or less empirically adequate and wanted to "explain[ed them] in terms of general and quite reasonable 'computational' properties of formal grammar" (p. 89) . . . So too we will assume here that Government and Binding Theory (GB) correctly limits the properties of [Universal Grammar/Faculty of Language] and our aim is to explain them on the basis of simpler, more general, more natural cognitive operations and principles.

Hornstein, following Chomsky, proposes to explain, among other things, the problems Ross identifies with non-local operations by reconfiguring operations and principles, seeking to redress the problems of non-locality by constraining operations and principles so they become less non-local, which is exactly what the "hidden variable" analyses of quantum entanglement sought to do (unsuccessfully). Hornstein's trust that getting the operations and principles right will resolve locality-related anomalies in grammar, unfortunately, misses the crucial point we have taken from physics that such anomalies are not law/rules/operation/principle anomalies, they are structural anomalies. To address these anomalies requires a reformulation not of operations and principles, but a reformulation of the domain over which operations and principles apply; in other words, it requires a reformulation of the biological base of human language, which we call Universal Grammar/Faculty of Language.

In this book, we take on the challenge of looking at the structural design of the Faculty of Language, arguing that the design proposed in Chomsky (1995, 2005, 2008) is a flat (Newtonian) structure that creates locality anomalies. As we point out, Chomsky's design for the Faculty of Language posits a structure that consists of three discrete, independent modules – a Lexicon, a computational system, and two interpretative External Interfaces (the Conceptual-Intentional interface and the Sensorimotor interface) – that have only operational connections with one another; consequently, any information shared by the modules must necessarily be "spooky action at a distance." We show that this design is flawed and needs to be reformulated as a curved design in which there are structural overlaps that allow information to be shared locally within and among the components of the Faculty of Language, which for us include the Lexicon, a computational workspace, and two performance systems (the Conceptual-Intentional performance system and the Sensorimotor performance system).

A crucial part of our argument for a radical re-conceptualization of the structural design of the Faculty of Language comes from evolutionary biology. We take seriously the suggestions made by Thompson (1917) and Turing

(1952) that mathematical and physical laws play a role in shaping biological form and structure by investigating the formal properties that determine the biological structure of the Faculty of Language: in fact, we make Turing's Challenge (to determine the formal properties of the Faculty of Language) the center of our analysis.

Of note, because we adopt Thompson's and Turing's views of biology, we also follow the constraint-based theories of evolution spawned by these views – theories such as those advocated by Fodor and Piattelli-Palmarini (2010), by Dawkins (2009), and by Deacon (2012). By adopting constraint-based theories of evolution, we accept that, as Fodor and Piattelli-Palmarini (2010: 21) observe,

> Contrary to traditional opinion, it needs to be emphasized that natural selection among traits generated at random cannot by itself be the basic principle of evolution. Rather, there must be strong, often decisive, endogenous constraints and hosts of regulations on the phenotypic options the exogenous selection operates on.

And we accept the related observation made by Deacon (2012: 427):

> Even in the case of the simplest organisms, an undirected, unconstrained process for sorting through the nearly infinite range of combinatorial variants of forms, and testing for an optimal configuration by trial and error of natural selection, would fail to adequately sample this space of possible combinatorial variations, even given the lifetime of the universe. In contrast to this vast space of possible combinatorial variants, the process of biological development in any given lineage of organisms is highly constrained, so that only a tiny fraction of the possible variations of mechanisms can ever be generated and tested by natural selection.

As Deacon and Fodor and Piattelli-Palmarini argue, evolution is not driven primarily by external forces (or exogenous natural selection); hence, evolution is not primarily an adaptationist process; it is driven instead by internal structures, self-organization, and self-assembly, all of which, in accordance with Thompson's and Turing's suggestions, conform to mathematical and physical laws.

We stress the importance of our constraint-based assumptions about evolution to highlight differences between the design of the Faculty of Language we propose and the one Chomsky proposes for standard Minimalism. Even though Chomsky often invokes his debt to Thompson and Turing in his formulation of the operations used in Minimalist syntax, his design of the Faculty of Language is strictly an adaptationist design (on top of being a Newtonian design, as we have discussed previously). For Chomsky, the Faculty of Language is designed to satisfy the Strong Minimalist Thesis (SMT), which holds that language is an optimal solution to interface conditions. What this means is that the computational system in the Faculty of Language produces output that optimally meets the interactive (and interpretative) needs of the external Conceptual-Intentional and Sensorimotor interfaces. In other words, under SMT assumptions, the computational system (a biological system) is designed to meet system-external (exogenous) conditions; it is designed to adapt to interface requirements imposed from outside of the computational system. An additional "adaptationist" problem with Chomsky's design of the Faculty of Language is that this design currently uses a "free" Merge operation to build syntactic structure – an operation that permits the computational system to build structures licentiously and relies on the interface systems to filter out unusable structures. However, as Deacon notes above, biological processes that freely produce combinatorial variants are untenable.

The case we are making here is that biolinguistic theories of syntax, particularly those currently proposed in the Minimalism framework, are built on a shaky foundation. Although such theories have devoted substantial attention to identifying the core "cognitive operations and principles" of grammar (as Hornstein 2009: vii asserts), they forego any analysis of the structural domain for these operations and principles, accepting without question the structural design advanced by Chomsky. Sadly, this design, as we have been arguing, suffers from being Newtonian and adaptationistic; consequently, much of the work done on operations and principles under Chomsky's design also suffers.

In this book, we are going to reverse Hornstein's analytical approach. Rather than pursue syntactic operations and principles in and of themselves, we pursue the structural design of syntax (of the Faculty of Language) and we investigate operations and principles only after we have ascertained the structural domain in which these constructs apply. Our analysis of the Faculty of Language will show that this faculty is not Newtonian and adaptationistic, but curved and constraint-based.

We build our analysis of human language around two core arguments. First, we argue that the design of the Faculty of Language that has evolved for human language has been, as Fodor and Piattelli-Palmarini observe of all phenotypic developments, "drastically limited by internal constraints" (2010: 25). In particular, we argue that the Faculty of Language is located within (and not separate from, as Chomsky proposes) the hominid performance systems that pre-existed language, and therefore, the evolution of the Faculty of Language has been constrained by these performance systems. Second, we argue that all the operations used in computing human language follow the same sorts of locality conditions that apply to all biological operations, as described by Dawkins (2009: 247):

> The development of the embryo, and ultimately the adult, is achieved by local rules implemented by cells, interacting with other cells on a local basis. What goes on inside cells, similarly, is governed by local rules that apply to molecules, especially protein

molecules, within the cells and in the cell membranes, interacting with other such molecules. Again, the rules are all local, local, local.

Of note, unlike Chomsky's design of the Faculty of Language, ours permits only bottom-up, strictly local operations that build structures on top of structures non-teleologically, without regard for their own output. In this way, our system of rules follows Dawkins (2009: 220), who notes of biological rules that

> The body of a human, an eagle, a mole, a dolphin, a cheetah, a leopard frog, a swallow: these are so beautifully put together, it seems impossible to believe that the genes that program their development don't function as a blueprint, a design, a master plan. But no: as with the computer starlings, it is all done by individual cells obeying local rules. The beautifully "designed" body *emerges* as a consequence of rules being locally obeyed by individual cells, with no reference to anything that could be called an overall global plan.

According to Dawkins, biological rules/operations are non-teleological (not being farsighted), but they are not blind. They are, however, intensely near-sighted. They are sensitive to, and constrained by, input conditions that allow material to be added to a biological structure only if the new material has an informational match with the existing structure. As Dawkins describes this biological accretion, cells in general bristle with "labels" (chemical badges) that enable them to connect with their "partners" (Dawkins 2009: 234). That is, cells, which possess a complicated array of "adhesion molecules" that are information-rich, participate in structure-building only if their information appropriately matches other cells. It is important to underscore the fact that for Dawkins, biological structures are built adhesively, not combinatorily. That is, biological rules are unary processes/operations that add material to a structure to grow that structure, and not binary processes/operations that combine two independent biological structures to form a third structure. The reason that this is important for our analysis of human languages is that our design of the Faculty of Language permits only Dawkins-type syntactic operations that are unary and adhesive (as we discuss at length in this book), while standard Minimalism has binary, combinatory operations. Hence, our structural design of the Faculty of Language aligns with constraint-theories of biology in ways that Chomsky's design (the design widely accepted in all versions of Minimalism) cannot, which provides a strong motivation for re-conceptualizing the structural design of the Faculty of Language along the lines we do.

Our primary objective in this Preface has been to establish the need to investigate the structural design of the Faculty of Language both in terms of the physics of locality and in terms of constraint-based theories of biology. We acknowledge from the get-go that our admittedly radical investigation will raise a host of controversial and uncomfortable questions about the design of human language that will encounter serious resistance, and we recognize upfront that

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there are many issues about structural design that will not be covered in this book, and these issues will be flagged as being problematic for us. However, we take some (perhaps undeserved) comfort from Kuhn (1962: 157), who points out that "if a new candidate for a paradigm had to be judged from the start by . . . people who examined only relative problem-solving ability the sciences would experience very few major revolutions." Aware that much work on the structure design of the Faculty of Language remains to be done, we move ahead with our analysis, confident that our call for shifting the paradigm of generative grammar deserves careful attention because our analysis promises productive connections with theories of biology that Chomsky's analysis cannot deliver. If, as Kuhn (1962: 157) asserts, "the issue is which paradigm should in the future guide research on problems many of which neither competitor can yet claim to resolve completely," we are certain our structural design of human language is built on principles most able to survive.

Acknowledgments

Every book manuscript has a unique story behind it, and this one is no different. The idea for this book actually came out of a pizza shop in downtown Kansas City, Missouri back in the spring of 2005. We discussed the idea of writing a "manifesto" of sorts regarding the contribution that the Survive Principle could make to the biolinguistic turn in generative linguistics. Since that day we have been working collaboratively on our "manifesto."

We have been fortunate to discuss some of our core (and peripheral) ideas developed in the book with many scholars, colleagues, and friends at a number of venues. Their critical feedback and probing questions undoubtedly aided us in revisiting many facets of our claims and ultimately pushed us to improve them. We would like to thank the following individuals for helping us clarify and shape our ideas: Klaus Abels, Marc Authier, Vicki Carstens, Mike Diercks, Sam Epstein, Antonio Fábregas, Helen Goodluck, Kleanthes Grohmann, John Hale, Wolfram Hinzen, Diego Krivochen, Winnie Lechner, Tim Osborne, Maria del Carmen Parfita Couto, Lisa Reed, Daniel Seely, Joe Salmons, Elly van Gelderen, Marjo van Koppen, Jerry Wyckoff, and Gilbert Youmans. There are others who have delivered helpful and insightful comments on our project at various stages of its development, and the omission of anyone's name is due to poor memory on our part.

Our ideas have also benefited from being presented at conferences and invited presentations. We would like to recognize and mention these venues and institutions for allowing us to present our work and, as a result, enhance it as a result of the feedback we received while there: DEAL (Descriptive and Explanatory Adequacy in Linguistics), Exploring Crash-Proof Grammars (Carson-Newman College), Johann-Wolfgang Goethe Universität, LASSO 37, MALC-2007, MALC-2009, Syntaxfest (Cyprus 2006), University of Michigan (Syntax Support Group), University College London, Universität Stuttgart, and University of York. In addition to these conference venues, the majority of the arguments concerning the structure of the Lexicon previously appeared in an article authored by Thomas Stroik entitled "The Lexicon in Survive-minimalism" (2009b). Our discussion of syntactic structure in relation to the system we develop and discuss in this book is based largely on our co-authored (Putnam and

Stroik 2010) book chapter "Syntactic relations in Survive-minimalism." We would like to thank John Benjamins Publishing Company for allowing us to republish these core ideas in this manuscript.

Thomas Stroik would like to thank, first and foremost, the University of Missouri-Kansas City for granting him a research leave in 2009–2010 to work on this book manuscript – with special thanks to Karen Vorst, Jeff Rydberg-Cox, and Ginny Blanton for making this leave happen. He would also like to thank the Department of Linguistics at University College London for providing him with a Visiting Professorship while he worked on the book in the fall semester of 2010. And to Michelle Boisseau, his wife, he says, "You are the heart and soul of everything I do. This book is for you."

Michael Putnam is thankful for his family, friends, and colleagues in their unyielding support of him and this project. This project (as is the case with most endeavors of this duration and length) took on a life of its own, and without supporters in your corner, it is virtually impossible to finish a book. Michael would like to thank his colleagues and students at Penn State University (especially Carrie Jackson and Richard Page), Richard Gray, John Littlejohn, Zachary Reichert, and Brad Weiss for being a constant source of reason and encouragement. A special thanks goes out to Ron Then and Nick Henry for their assistance in creating an index for this book. In addition to these individuals, Michael would like to issue a very special thanks to his parents for their continued unconditional support of his work throughout his career. Finally, Michael would like to thank his wife, Jill, and daughter, Abby, for their unyielding patience and love throughout this project – "I couldn't have done it without you guys!"

Abbreviations

AP	adjectival phrase
ATB	across-the-board
BAE	Bare Argument Ellipsis
CI	concatenated items
C-I	Conceptual-Intentional
CoN	Copy-to-Numeration
CoSD	Copy-to-syntactic derivation
CP	Complementizer Phrase
CS	computational system
CUD	Copy's Uniformity of Directionality
DM	Distributed Morphology
DP	Determiner Phrase
EF	edge feature
EM	External Merge
FL	Faculty of Language
FLB	Faculty of Language broad
FLN	Faculty of Language narrow
FM	Feature Matrix
GB	Government and Binding
HP	Head Phrase
HPSG	Head-driven Phrase Structure Grammar
IM	Internal Merge
LEX	Lexicon
LF	logical form
LFG	Lexical Functional Grammar
LI	lexical item
MLC	Minimal Link Condition
NP	Nominal Phrase
NUM	Numeration
PF	phonetic form
PHON	phonological-feature set

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PP	Prepositional Phrase
PSF	performance system feature
PSI	performance system item
QP	Quantifier Phrase
QR	quantifier raising
SCT	Strong Computational Thesis
SD	syntactic derivation
SEM	semantic-feature set
SM	Sensorimotor
SMT	Strong Minimalist Thesis
SYN	syntactic-feature set
TDI	Type Driven Interpretation
VP	Verb Phrase
WB	WorkBench