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Language down the garden path: The cognitive and biological basis for linguistic structures. Ed. by MONTERRAT SANZ, ITZIAR LAKA, and MICHAEL K. TANENHAUS. Oxford: Oxford University Press, 2013. Pp. 518. ISBN 9780199677139. \$45.

Reviewed by JULIE FRANCK, *University of Geneva*

Language down the garden path leads the reader into the meanders of more than forty years of research since the publication of Bever's 1970 article 'The cognitive basis for linguistic structure' (CBLS). The book mirrors the nature of CBLS in compiling an eclectic set of chapters addressing a variety of key theoretical questions, hypotheses, and observations about language and its relation to other domains of cognition. The book also mirrors the evolution of the cognitive science of language, which has spread in a wide array of directions. It encompasses different theoretical frameworks, diverse objects of study, and various levels of key phenomena explored through multiple research methods. While the diverse ideas of CBLS were developed in a single paper by a single researcher with the aim of reaching a unified view of the study of language learning and processing, a significant part of the field today is parceled, with sometimes little interpermeability of people and ideas. Notably, then, this book puts people and ideas together again, with the challenging aim of reunifying the different research pathways around the major question of the relation between competence and performance. The last decade has indeed witnessed a new interest in drawing links between the various pockets of knowledge accumulated in isolation, with models linking production, comprehension, and learning (see chapters by THOMAS G. BEVER; GARY S. DELL and AUDREY K. KITTREDGE; CHIEN-JER CHARLES LIN; MARYELLEN C. McDONALD; COLIN PHILLIPS; and DAVID J. TOWNSEND) or research programs linking behavioral or neurophysiological data to the fine theoretical tools of linguistics (see chapters by INA BORNKESSEL-SCHLESEWSKY and MATTHIAS SCHLESEWSKY; EWAN DUNBAR, BRIAN DILLON, and WILLIAM J. IDSARDI; JANET DEAN FODOR; YOSEF GRODZINSKY; SIMONA MANCINI, NICOLA MOLINAR, and MANUEL CARREIRAS; JACQUES MEHLER; MASSIMO PIATTELLI-PALMARINI; Colin Phillips; MONTERRAT SANZ; and VIRGINIA VALIAN).

The book starts with a reprint of CBLS, whose core question is the relation between internal linguistic structures and external input sequences. On Bever's view, the key link between the two

lies in the 'analysis-by-synthesis' approach, according to which language processing takes place in two steps. During the first step, 'perceptual strategies' ensure a direct mapping between the surface structure of the sentence and thematic roles, generating a rough, plausible meaning for the sentence. This early analysis is then 'synthesized' during a derivational step responsible for building a phrase structure for the sentence and checking that it converges with the output of the initial quick-and-dirty analysis. CBLS introduced the idea developed later that 'we understand everything twice' (Townsend & Bever 2001). It is interesting that this approach seeded the idea of a two-stage decomposition of the comprehension process, one of the major tenets of the modular approach, although the modular model flipped the temporal order of the two components, arguing for an early, syntax-based process followed by a late integration of other types of information.

Bever's hypothesis that the form of grammar is determined by general constraints from cognition constituted a radical shift from the generative approach, dominant at that time. It questioned its overall relevance as a model of language processing, but also its methodology. Indeed, if the grammaticality judgments used to develop the model of grammar are themselves the output of the performance system, Bever asks what the science of linguistics is a science of. As Tanenhaus writes in his afterword, CBLS was an invitation to 'thinking out of the box', and this invitation helped spawn an immensely varied and fruitful research program exploring the cognitive bases of language structure. But CBLS may also be viewed as bearing some responsibility for the splitting apart of psycholinguistics and linguistics. Many psycholinguists, in the process of thinking out of the box, effectively threw it away by losing track of the question of how to characterize internal linguistic structures. On the other side, theoretical linguists working within the generative framework have for the most part steered away from the concern of understanding the mental processes in sentence comprehension. However, although Bever's position in CBLS could have been understood as a rejection of the derivational model, it was actually more nuanced. First, Bever did not claim that perceptual strategies were the only processes at play in comprehension; his second, synthetic stage of sentence processing involves a derivational process. Thus, he left the door open to the possibility that the derivational theory of complexity might be true computationally, even though it does not show up in a simple way in behavior (Bever & Poeppel 2010). Second, by arguing that language acquisition and use play a causal role in the shaping of grammatical structures, Bever actually envisaged a tight relationship between competence and performance.

Tanenhaus writes about CBLS: 'It combines deep insights with a loosely constructed and sometimes confusing structure. As confused as one might be, though, one senses that the author knows and can see things that nobody else knows or sees' (407). *Language down the garden path* shows the same characteristics: a total of twenty-one chapters by some of the most prominent figures of linguistics and psycholinguistics, concatenated on a great diversity of topics with no overarching structure, allowing the reader to navigate freely across ideas and viewpoints. In the introduction, Sanz, Laka, and Tanenhaus browse the various chapters, following a possible connection path between them, which they consider to be necessarily imperfect given the various alternative ways of organizing ideas. Here, I follow one of these alternative groupings in briefly reviewing the ideas.

Bever's analysis of garden-path phenomena, illustrated in his well-known sentence *The horse raced past the barn fell*, was that the difficulty was due to the speaker's application of perceptual strategies based on personal experience with the language, which allows him to predict a likely meaning. Prediction as a key mechanism underlying the relationship between general properties of cognition and language processes occupies a central role in the book, whose focus is primarily on the cognitive determinants of language processing and learning. GERRY ALTMANN discusses the rise of the constraint-based approach, according to which the same predictive, probabilistic mechanism underlies the processing not only of ambiguous sentences but also of unambiguous sentences. He reviews work showing that the prediction mechanism linking language to knowledge of the conceptual structure of events goes both ways: real-world events allow prediction of what will come next in the sentence, but the sentence also allows anticipation of what will come next in the event. The constraint-satisfaction approach is further developed by Maryellen MacDonald, who extends the model to the processing of object relatives. She describes the 'production distribution comprehension' framework, according to which distributional patterns con-

straining comprehension arise from constraints from the speaker: speakers' choices create robust distributional patterns that are learned by language users and determine their expectations about upcoming input during comprehension. Along similar lines, Gary Dell and Audrey Kittredge present the psycholinguistic-chain (P-chain) model, a framework that links perception, production, and acquisition through mechanisms of prediction and implicit learning. The authors describe each of these links, combining evidence from experimental research and connectionist modeling. Two chapters explore the relationship between language and cognition through the specific role of memory as a determinant of sentence processing. EDWARD GIBSON, HARRY TILY, and EVELINA FEDORENKO address three major types of explanations for the difficulty of object relatives: reanalysis-based theories, experience-based theories, and working memory-based theories. They review a wide literature on relatives and conclude that there may be multiple sources of difficulty, some lying in statistical properties of linguistic experiences, others lying in the mechanism for retrieving distant elements from working memory. The mechanism of memory retrieval is discussed by BRIAN MCELREE and LISBETH DYER, who argue in favor of a bipartite architecture consisting of a focus of attention and a memory responsible for accessing past events through direct-access, content-addressable retrieval, similar to long-term memory retrieval. They review studies attesting to the role of a cue-based retrieval process in the processing of long-distance dependencies in language.

Some contributions develop, in line with Bever in CBLs, the approach combining the role of general cognition and language-specific influences in language processing. Ina Bornkessel-Schlesewsky and Matthias Schlewsky's chapter explores Bever's insight that language universals are rooted in cognitive universals about language learning or use. They provide the reader with a snapshot of neurotypology and the core hypothesis that the brain constrains typological properties of languages, either directly or indirectly by way of its influences on cognition. Chien-Jer Lin discusses garden-path effects and difficulties with object relatives, arguing that both result from the incorrect initial analysis based on Bever's probabilistic 'NVN' heuristic, according to which agents precede patients. He reviews evidence from relative-clause processing in both head-initial and head-final languages suggesting that comprehension is easier for relatives for which the thematic order is in line with the heuristic. However, speakers across languages show a preference for subject relatives, even when they have a noncanonical thematic order. Lin suggests that in contrast to the heuristic nature of the comprehension process, production is guided by hardcore syntactic constraints on the extractability of syntactic positions. The hypothesis that strategies and rules cohabit is also adopted by David Townsend, who discusses some of the perceptual strategies proposed by Bever in CBLs in light of recent empirical evidence. His review leads him to reaffirm the distinction between comprehension and grammar: comprehension operates on the basis of statistical patterns, allowing an immediate 'impression of meaning'; grammar then specifies that initial linking between patterns and meaning.

A number of chapters argue in favor of a tight, integrated relationship between competence and performance. Colin Phillips provides a critical analysis of Bever's hypothesis that grammar does not directly take part in real-time comprehension. He reviews and dismisses five arguments that have been put forth against grammar theory as a theory of mental processes: the failure of the derivational theory of complexity, the challenge of the strictly bottom-up nature of the generative model, evidence for various 'perceptual strategies', the slowness of grammaticality judgments, and evidence for the distinction between parsing and production. Phillips concludes that a heuristic process that is independent of grammar is not viable. Simona Mancini, Nicola Molinaro, and Manuel Carreiras propose an account of agreement that capitalizes on computational devices from the minimalist program like Agree, but departs from minimalism in hypothesizing different interpretive requirements for person and number. The authors review behavioral and ERP studies that consistently speak against the syncretic representation of these agreement features. Montserrat Sanz argues that the progressive shift of interest in linguistics from content to functional items has contributed to its drifting apart from psycholinguistics. She describes a model of garden-path effects based on the linguistic structure of the event phrase. The event phrase is part of the functional structure, but its projection contains semantic features that cause overt syntactic operations,

thus reopening a possible link between the two disciplines. Two chapters discuss more specifically the role of prosody in language processing and acquisition. Janet Dean Fodor argues that the difficulty in processing center-embedded structures arises from difficulty with aligning syntax and prosody. The implicit prosody hypothesis capitalizes on the early idea of packaging, now conceived of as arising from the prosodic component of the grammar responsible for dividing strings into prosodic phrases suitable for pronunciation. Jacques Mehler also addresses the close relationships between prosody and grammar, providing the reader with a tour of some of the major pieces of evidence for the role of prosody in two major mechanisms of language acquisition: statistical learning, and the generalization that underlies rule-based behavior.

The question of the abstractness of language representations is at the heart of many chapters. Massimo Piattelli-Palmarini discusses language universals, which he argues are akin to natural kinds. He discusses the mathematical property of conservativity of determiners and notes that although imaginary determiners that violate this property are not 'hard for thought' and do not impede communication, they are unattested in natural languages. He proposes that conservativity is an example of a universal, abstract, domain-specific principle. Also focusing on determiners, Virginia Valian argues that their knowledge relies on an innate, abstract schematic representation, underspecified with respect to form. These schemas involve the fact that determiners are heads of determiner phrases, that they take noun phrases as complements, and that they can enter into an agreement relation with nouns. EDWARD STABLER discusses various conceptual obstacles to the science of language and cognition, including the lack of consensus on even basic theoretical claims. He highlights an abstract computational property that nevertheless appears remarkably uncontroversial across theories, that is, that languages are both weakly and strongly mildly context-sensitive, and draws links between recent 'rational' computational approaches to mildly context-sensitive languages and the 'analysis-by-synthesis' model. In his chapter, ROBERT BERWICK discusses the tension between models of external behavior and models of language knowledge. The measure of merit of the latter, like generative grammar, lies in their ability to capture linguistic data by way of the simplest law-like generalizations. Berwick argues that Chomsky's criterion of the minimum description length, at the heart of modern work on formal inference, does the same work as Bayesian inference methods that attempt to find the most likely grammar. The Bayesian 'model comparison' approach to inference under uncertainty is illustrated by Ewan Dunbar, Brian Dillon, and William Idsardi on the question of the learning of the phonological grammar of Kalallisu. The learning problem is approached at an abstract level by identifying the optimal solution for the learner, rather than by exploring the actual mechanisms used by the child. Inherent properties of Bayesian inference force the choice of an abstract, opaque analysis rather than a transparent analysis.

Two contributions hinge on the question of the domain-specificity of language. LUCIANO FADIGA and ALESSANDRO D'AUSILIO argue for a common computational mechanism underlying tree-like structures in syntax and in the motor system, and address the question of the relationship between hierarchical representations and their sequential realization in time. Recent models of the prefrontal cortex suggest that different levels of abstraction of action are specified at different functional nodes, such that progressively posterior regions are responsible for integrating more concrete information over shorter time windows. Yosef Grodzinsky critically assesses the hypothesis of a domain-general language function. He reviews various arguments provided against language specificity, both at the computational and neurological levels, and shows that general properties of cognition fail to capture the observations. In contrast, the data find a natural explanation through the toolkit of linguistic theory, illustrating the necessity of a closer collaboration between physiologists and linguists.

Finally, Bever reviews the evolution of some major topics of CBL in light of his own work. In the spirit of CBL, he identifies important topics for the future, one being the puzzling impoverishment of the acoustic signal. This not only makes the argument of the poverty of the stimulus even more compelling, but may also provide key insights about the tension between the linearity of language and its fundamentally hierarchical structure: we are usually unaware of incomprehensible segments of speech, even when they are disambiguated by later material. Bever puts forth the concept of time-free 'psychological moments', referring to a portion of time during

which processing would move both forward and backward on hierarchically organized chunks that would be internally order-free.

The book ends with a brief description by some of the contributors of what is in store for the future of the scientific study of language. A recurrent theme involves bringing the study of language closer to other disciplines, such as neurolinguistics, neurobiology, bio-physics, the science of reasoning under uncertainty and probability theory, computational linguistics, and cognitive robotics. Despite the very different viewpoints developed across the various chapters of the book, a consensus seems to emerge on the need for thinking together and overcoming the still ongoing and unfortunate separation between linguists and psycholinguists through exchanges and books like this.

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How children learn to write words. By REBECCA TREIMAN and BRETT KESSLER. Oxford: Oxford University Press, 2014. ISBN 9780199907977. \$84 (Hb.)

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In this ambitious book, Treiman and Kessler provide in-depth descriptions of how written scripts capture oral language and how children learn to use them. The diversity of information as well as the abundance of illustrative examples presented will be of interest to educators and researchers alike.

After an introductory chapter, T&K quickly and deeply immerse the reader into the intricacies of writing systems. At forty-two pages, Ch. 2 is the longest and densest chapter in the book. This is not an easy read, but will gratify those who take notes and construct tables. It is here that the authors describe the outer forms of writing scripts and at what level they represent oral language, be it at the word, syllable, or phoneme level. Perhaps the most useful information for educators is found in Chs. 3 and 4. Here we learn that children's perceptual skills and language knowledge can ease the task of becoming literate. T&K argue convincingly that humans are built, from the get-go, to detect patterns. The review of existing models of spelling acquisition in the next chapter sets the ground for the authors' proposed model of learning to spell: the INTEGRATION OF MULTIPLE PATTERNS (IMP). According to the IMP, there are at least two classes of patterns to be learned: patterns regarding the outer forms of letters, and patterns regarding the links between graphic forms and language. To learn about these patterns, children rely on general learning

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