Preface

The chapters in this volume,[1] now extensively revised for publication, were first presented in Tokyo 16–17 November, 1998, at the first symposium of the Mind Articulation Project, a joint MIT/JST (Japan Science and Technology) research project conducted under the auspices of JST's program of international cooperative research (ICORP).

The Mind Articulation Project, codirected by two of the editors of these proceedings (Yasushi Miyashita and Wayne O'Neil), arose largely through the efforts of the third editor, Alec Marantz. This first symposium, a joint undertaking of the three of us, brought together eleven linguists and cognitive neuroscientists (in addition to Marantz, Miyashita, and O'Neil): Noam Chomsky and Edward Gibson (both of MIT), Robert Desimone (NIMH), Richard Frackowiak (University College London), Angela Friederici (Max Planck Institute/Leipzig), Masao Ito (RIKEN), Willem Levelt (Max Planck Institute/Nijmegen), Jacques Mehler (CNRS), Helen Neville (University of Oregon), David Poeppel (University of Maryland at College Park), and Hiroshi Shibasaki (Kyoto University).

One goal of the symposium was to examine the recent attempts to unify linguistic theory and brain science that have grown out of the increasing awareness that a proper understanding of language in the brain must reflect the steady advances in linguistic theory of the past forty years. How can the understanding of language provided by linguistic research be transformed through the study of the biological basis of language? How can our understanding of the brain be transformed through the same research? The best model of such interaction between cognitive science and neurobiology is research on vision. Abilities such as visual awareness, attention, and imagery generation are the first higher cognitive abilities to have been firmly localized in the brain. Key findings on these matters have been enhanced by the recent explosion of noninvasive brain-monitoring techniques that have been most successfully applied in the investigation of the functional anatomy of the visual system.

The long-term goals of the project are, on the one hand, to integrate linguistics and brain science in the way that has been attempted in the study of the visual system,

and, on the other hand, to formulate a cognitive theory that more strongly constrains visual neuroscience.

The chapters in this volume explore some of the topics just sketched, addressing the goals both of the symposium and of the project. Thus, some chapters examine the current status of the cognitive/neuroscience synthesis in the study of the visual system. Other chapters address whether and how linguistics and neuroscience can be integrated, given the paradigm of cognitive neuroscience emerging from work on vision. Still other chapters, though focused on vision, are primarily concerned to illustrate "how integrative brain mechanisms can be studied" through the use of the various noninvasive brain-imaging techniques (see chapter 8).

For example, in chapter 11, Reynolds and Desimone integrate these approaches and propose that attentional modulation depends on two interacting neural mechanisms: one, an automatic competitive mechanism within a cortical area, and the other, feedback from outside a cortical area that biases the competition in favor of the neuronal population activated by the attended stimulus. They present a simple computational circuit that provides a good fit to the data and makes easily testable predictions.

Miyashita begins chapter 12, on the neural mechanism of visual imagery, by quoting Alain: "Create an image of the Pantheon in your mind. Can you count the columns that support its pediment?" The basic neural circuit of imagery generation is drawn in comparison with the cognitive model of Stephen Kosslyn. Two predictions of the circuit were directly tested by neurophysiological approaches in animal models: activation of internal representation of objects in the inferotemporal cortex and its executive control by the prefrontal cortex.

As for the chapters on language, we will not comment on all of them, but let us at least note that Levelt and Indefrey's reanalysis (in chapter 4) of fifty-eight reports of brain-imaging experiments on word production from the point of view of an independently arrived at theory of lexical access in speech production reveals a remarkable convergence between the theory and the experimental data. This convergence leads them to wonder about "how much more can be achieved if a processing theory is used beforehand to guide the planning of functional brain-imaging studies of language?" And in chapter 6, Friederici presents "a tentative model of the neuronal dynamics of auditory language comprehension" according to which "early syntactic processing is independent of lexical-semantic information [, which] only comes into play when thematic roles are assigned. If initial syntactic structure and thematic structure map well, comprehension has taken place adequately." Her results have clear implications for psycholinguistic models of language comprehension.

Finally, consider the research by Poeppel and Marantz on the perception of the sounds of language, presented in detail in chapter 2. The preliminary results of this

work, firmly based in the theory of phonology, suggest that the interface between the sounds of language and the cognitive system of language is embedded in the articulatory-perceptual system. Part of auditory cortex thus appears to be language dedicated, a surprising result if supported by further research.

In chapter 1, Chomsky expresses some caution, however. Commenting on the work of the past fifty years, he points out that although

> there has been intensive and often highly productive inquiry into the brain, behavior, and cognitive faculties of many organisms [, t] he goal that has aroused the most enthusiasm is also likely to be the most remote, probably by orders of magnitude: an understanding of the human brain and human higher mental faculties, their nature, and the ways they enter into action and interaction.
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> From the outset, there has been no shortage of optimistic forecasts, even declarations by distinguished researchers that the mind-body problem has been solved by advances in computation, or that everything is essentially understood apart from the ''hard problem'' of consciousness. Such conclusions surely do not withstand analysis. To an objective outside observer—say, a scientist from Mars—the optimism too might seem rather strange, since there is also no shortage of much simpler problems that are poorly understood, or not at all.

Chapter 5, by Gibson, is in part an illustration of Chomsky's last point. Working on problems of complex sentence processing that Chomsky, together with George Miller (in Miller and Chomsky 1963), addressed over thirty-five years ago, Gibson reports progress that results entirely from behavioral studies, and not at all from brain-imaging technology.

Thus, the conclusion to Chomsky's paper serves as a fitting and challenging end to this prefatory essay as well:

> Exactly how the story unfolds from here depends on the actual facts of the matter.... A primary goal is to bring the bodies of doctrine concerning language into closer relation with those emerging from the brain sciences and other perspectives. We may anticipate that richer bodies of doctrine will interact, setting significant conditions from one level of analysis for another, perhaps ultimately converging in true unification. But we should not take truisms for substantive theses, and there is no place for dogmatism as to how the issues might move toward resolution. We know far too little for that, and the history of modern science teaches us lessons that I think should not be ignored.

To say that the chapters of this volume originated at the *first* Mind Articulation Project symposium is to presuppose that there will be at least a second symposium, at which time we hope to know better how far we have traveled along the path toward the unification of the brain and cognitive science, if at all.

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Note

1. This volume contains one paper not presented at the symposium, the paper by Kensuke Sekihara, David Poeppel, Alec Marantz, and Yasushi Miyashita, and lacks a paper that was presented, a paper by Helen Neville.

Reference

Miller, George A., and Noam Chomsky. 1963. In *Handbook of Mathematical Psychology*, volume 2, ed. R. Duncan Luce, Robert R. Bush, and Eugene Galanter, 419–491. New York: John Wiley and Sons.