JOHN C. L. INGRAM. *Neurolinguistics*: *An introduction to spoken language processing and its disorders*. (Cambridge Textbooks in Linguistics). Cambaridge, New York: Cambridge University Press. 2007. xxiv, 608.

This is a remarkable textbook, written by a scholar with considerable experience across numerous subdisciplines in language studies and linguistics, and that shows in the approach. It exceeds the scope of primary theoretical constructs and comprehensive review of the research in the field by providing critical discussion of key developments. The text follows a sensible, bottom up arrangement in presenting the topics and discussing the research, in which readers are led through the arguments for each theoretical construct and into the problems which subsequent research and counter-theories pose. The field crosses numerous disciplines, including speech pathology, communicative disorders, psycholinguistics, theoretical linguistics, applied linguistics, and neurology. This text requires a firm grounding in general linguistics principles and at least a basic grounding in the aforementioned fields. A brief sample may suffice to demonstrate the presuppositions for the audience, "A relationship of C-command holds between nodes X and Y if the first branching node that dominates X also dominates Y" (33).

Reader engagement with the text is aided by frequent "practice tests" in which penetrating questions regarding presuppositions and implications of the theories in question are posed. To the author's credit, he neither mystifies the neurological science nor treats it with the reverence due received wisdom, but offers a sound critical analysis which builds through the text. For example, in discussing the "inverse problem" involving the difficulty of calculating magnetic current levels from structures interior to the brain at its surface in an effort to chart the sources of activity during language processing tasks, where the "number of generator loci is an open question," it is pointed out that this problem is serious, as is that of separating language-specific neurological activity from other functions (62-3); whether the stimulus is presented aurally or

visually, the neurological systems and cognitive engagement involved render the problem exponentially more acute. These considerations counter-balance the neat conclusions from the research. The appropriately dense scientific and academic prose is broken up by refreshing, folksy, and figurative locutions, such as found during one critique, "If this is not skating on thin ice, then penguins can fly in a strong wind. Such is the nature of studies of on-line indices of psycholinguistic processes" (319). The result is a text that, although necessarily compact, is readable and pleasing.

The field can be introduced by the observation that linguistic theory investigates and describes language as a system of communication, while the "neuropathological approach" investigates language failures as a consequence of brain damage (see 66, f). Thus, by applying the elements of human language described to observations about those functions that are impaired because of organic damage, we can arrive at a theory of human language.

This of course raises another fundamental question: Does damage to a part of the brain implicated in a diminished language function indicate that that part of the brain is responsible for the normal function? That is, for example, does the observation that patients with damage to Broca's area manifest certain impairments entail that neurons in that area are the source of the capability in question? This question arises in other forms, involving a certain terminological ambiguity in the field, the *brain* and the *mind*. In the discussion of the "co-evolution hypothesis" the two terms seem to be equated (5-7), but later, we read, "If only the workings of the mind or the brain were so readily observable" (58), and "mental and neural operations" involved in understanding language (243); these seem to imply two entities and functions. Some readers may recall that in Chomsky's formulation of the LAD, assigning a locus for that part of the "mind" was self-consciously avoided (Chomsky, Noam. 1965. *Aspects of the Theory of Syntax)*.

A very apt question is asked in regard to the preceding question: "What does the language processor know and when does s/he know it?" (264). Let us look briefly into the presuppositions of this question. One possibility is that the gender-inclusive hybrid pronoun is merely the product of an editor's politically correct solution to the prescription that a 3PS pronoun must accord with "language processor" (but then, why not *it*?). Otherwise, the question presupposes a cognizing center, a seat of consciousness, an attention-focusing subject who is capable of meta-awareness of language, of self, and of self identity, replete with gender identification.

Also relevant here is the fact that on-line studies of cases with grammatical comprehension impairment show that the phenomenon is graded, not categorical, and that neurologically less impaired patients manifest the same types of anomalies as seen in normal speakers (324 - 26). Add to that the well known findings in patients who have undergone *corpus callosotomy* (brain bisection), where it is recognized that a unitary sense of personal identity persists in these patients (e.g., Grant Gillett. Brain Bisection and Personal Identity. *Mind*, *Vol. 95*, No. 378 p. 224-229, Apr., 1986), and that right brain language processing continues in varying degrees in all four competencies (e.g., Michael S. Gazzaniga. Right Hemisphere Language Following Brain Bisection: A 20-Year Perspective. *American Psychologist*, *V38*, No. 5, p. 525-37, May, 1983). If a theory of language and studies of neuropathology are to triangulate on elements that make possible identifying and comprehending the anatomy of human language capability, the questions raised by these findings have important implications for the eventual construct of the model.

The choice of theory of language likewise becomes critically relevant here, witness competing models of sentence parsing, the "modular," in which "lexical access and syntactic

structure assignments … rely upon distinct mental or brain resources" [mind / brain again!] and the "interactional," where both "are … governed by the same processing considerations" (249 - 50). The minimalist model of generative grammar, for instance, with its right-to-left processing model (245 – 58) requires an elaborate structure of buffers to retain perceptual information in memory while awaiting syntactic match-up, along with pathways to access them, which must be postulated among the neurological anatomy.

Difficulties in modeling the anatomical constituents of language processing involve how to measure speech-related events and how to interpret the results. Event related potential recording (ERP) of brain activity in response to linguistic stimuli leads to the conclusion, among others, that "at 400 ms post-stimulus, a sentential semantic representation is formed" (62). This is the time elapsed between the introduction of the linguistic, i.e., sensory, stimulus and reading the surge in potential in left central (temporal) regions at the electrodes applied to the skull of the subject. This signal surge is taken in the literature to support the theory of a modular processing function (ibid.). This time span, though, strikes one as an inordinately long interval between sentential input and comprehension. Diffusion of NA into the axon membrane (at about 1 ms) and K out of the axon membrane (at approximately 2 ms) is responsible for the action potential of nerve impulses. Postsynaptic cell reactions include deactivating ACh at receptor proteins on the membrane. These reactions cascade among neurons across multiple sensory systems. Clearly the ERP shows a gain in electrical potential in several stages on the surface of the region, but assumptions about the significance of what is being measured are difficult to support.

Every generation seems to adopt a common metaphor. As Aristotle pointed out (*The Poetics*), *tropes* help hearers apprehend the object of discourse by applying features of more familiar objects. Perhaps because of greater simplicity it offers, a metaphor grows popular, and

references to it become ubiquitous as more and more writers follow the trend. The social sciences, thankfully, have survived the confusions spawned by the Darwinian social model, i.e., the *evolution* metaphor, applied to language and culture. One need read very little research since the 1960s to find that what the author calls "the tired digital computing metaphor" (377) has become pervasive. The field is saturated with terms and concepts borrowed from digital computing, such as *processing machinery*, *on-line* and *off-line processing*, *hardwired*, *architecture*, *buffer*, *storage*, *circuit*, *parser*, *processing load*, *mapping*, *crash*, *module*, etc., along with charts and sketches that look for all the world like those found on the pages of elementary computer manuals. Articles in historical linguistics even reduce statements of proposed processes of change to so many lines of programming code. The error in this situation is that the metaphor, which is more straightforward and easier to apprehend, overpowers the actual object, which here is not only impossible to observe directly but complex beyond our present comprehension, with the result that it replaces the object in our consciousness, i.e., we cognize the metaphor *as* the object.

Speech recognition, for example, is discussed in the research in digital metaphor terms, e.g., "*mapping* the acoustic *signal* of speech onto articulatory *targets*" (emphasis added, 101), but the quite variable phonological realizations of "I'm going to leave," ranging from [aɪmgoʊəŋtəliv] to [aŋgəliv], (99) demonstrate the folly of such models; as is pointed out, "machine speech recognizers typically have great difficulty making these accommodations" (98). Efforts at artificial intelligence and speech processing have moved in the direction of complex statistical networks and very large corpora (220), which is just how digital processing systems work, but without achieving more than quite rudimentary function.

When examined in detail, the digital computing analogy breaks down functionally. Digital computing devices function *serially*, i.e., one bit at a time; the CPU looks here and there, according to routines *hard wired* into its *architecture*, sends *signals* here or there, receives signals, *circuits* are activated, *routines* are undertaken, each one step at a time, one instruction for each *clock tick*, in a manner and sequence specified by the *program* running in the *environment* of the *operating system* on the *machine architecture*, these the products of intelligent programmers and engineers external to the computer and its function. But while speech production and speech reception are serial events, i.e., a relatively contiguous auditory stream is linearly produced and received (not the case, however, in writing and reading), the myriad events that occur during speech events and the complex interactions between speech and cognition in speaker and hearer are multiple, multiplex, simultaneous, and virtually instantaneous (e.g., Piennemann, Manfred. *Language processing and second language development: processability theory*. Amsterdam, Philadelphia: John Benjamins Publishing Company, 1998, 57-8), while their application is being handled on the fly by speakers / hearers, subject to their conscious control. Thus the author is correct in recognizing that "the great adaptive capacity of the human perceptual processor … provides a major challenge to current theories" (142).

A parallel point regarding theories of semantics and syntax must here be evoked. In a system of formal semantics it is common to posit abstract sentences which have this or that "reading," i.e., in a given utterance situation, they can bear this or that meaning. Experimental research in agrammaticism, correspondingly, has subjects respond to acontextual sentences containing potential ambiguity, "garden path sentences", ungrammatical structures, and the like. But if it is the case that human language is a communication system, we do not communicate in *sentences* (in the formal semantics sense) in the abstract, but in *utterances* which occur in

specific communicative contexts. Thus in human language communication, the context is always part of the "reading," and such experiments do not reflect authentic communicative situations involving human language. What produces the situation that speakers appear to have preferences for this or that "reading" of ambiguous sentences is a very good question (259), but I do not think it will be answered by research grounded in formal semantics.

Nor can I agree with the conclusion that syntactic information "normally overrides pragmatic expectations" (251). Consider the case when a speaker recently stated, "As a child my father told me stories about raising me at sixteen." No one listening took the "reading" that his father was so precocious as the utterance made him sound. And regarding the following exchange,

Peter: *Did John pay back the money he owed you?*

Mary: *He forgot to go to the bank* (336),

I would add to the very satisfactory Gricean analysis provided and the very apt observation that the "chain of inferences," may well not follow the linear sequence implied by their exposition, the fact that when this "chain of inferences," or, as it were, *web of implicature*, is accounted for, we are still not finished with our analysis of the speech event. When considering prosodic factors, which are conventional for speech communities and therefore elements of the language system, we recognize that Mary's remark may be construed as mocking, ironic, exasperated, or apologetic. We must go this far and beyond to approximate a useful model of language processing. Since speech apprehension very clearly interacts with simultaneous cognitive operations, identifying the neurological components of specific speech processes still falls far short of describing speech processing.

Errata. The otherwise very helpful glossary lacks an entry for *modularity* (9) and *troponymy* (203), despite these being marked in bold type as glossary entries. The index, which represents the neurological topics more than the linguistic, proved only somewhat useful in locating topics for rereading.

This text offers an excellent, critical review of the field, and it provides a thorough grounding in the problems that it faces. I particularly recommend it to lecturers in the aforementioned related disciplines as a survey of the current state of the subject, both for the sake of the information presented and as a potential check against training dominated by one theoretical construct or another. More than a dozen theories of language function have currency in the literature. Given this somewhat parochial climate, the author's closing remarks are sobering indeed:

> fundamental problems to do with the nature of linguistic representations in a model of language processing remain, and whether these prove tractable to scientific investigation, in our quest to fulfill the goals of a cognitive science of language, only time, as they say, will tell (379).

Robert D. Angus
California State University, Fullerton