
BOOK REVIEWS

Speaking Clearly: Reviewing Aphasia From Assessment to Treatment

DOI: 10.1017/S1355617704211079

Assessment of Aphasia. O. Spreen and A. H. Risser. 2003. New York: Oxford University Press. 320 pp., \$47.50.

Aphasia and its Therapy. A. Basso. 2003. New York: Oxford University Press. 317 pp., \$47.50.

Reviewed by ANNA B. MOORE, Ph.D. and TIM CONWAY, Ph.D., *Brain Rehabilitation Research Center, Malcom Randall VAMC, Gainesville, FL; Department of Clinical & Health Psychology, College of Public Health and Health Professions, University of Florida*

Paul Broca's famous case reports of language impairment following left hemisphere lesions were issued in the 1860s. Since that time, much has been written about the assessment, typology, and neural underpinnings of aphasia. The two books we had the pleasure of reading and reviewing, *Assessment of Aphasia* and *Aphasia and its Therapy*, present well thought out and thorough reviews of aphasia literature, the first focusing on assessment issues, the latter focusing more on issues of and theoretical approaches to treatment. The books are united in their insistence that the field of aphasia research, from assessment to rehabilitation, be grounded in theory and a defensible conceptual model. This overarching theme presents itself throughout the entire corpus of both texts. Just as the clinician conducts a thorough assessment before initiating treatment, so too will this review begin with the book focused predominantly on aphasia assessment, before moving on to aphasia therapy.

Assessment of Aphasia consists of short, easily digested chapters that cover the basics of both test construction and assessment principles in general, with descriptions of an admirably thorough list of tests for use in children, adults, and populations with unique considerations. The authors note that the book is intended for practicing speech pathologists and neuropsychologists, as well as for graduate students seeking to understand the assessment of speech and language disorders. The book is well organized into four sections, each of which could stand alone as a complete entity. Section I provides the general introduction to the topic of aphasia by highlighting global issues of assessment, history of aphasia assessment, and principles of aphasia test construction. Sections II and III contain descriptors of test format and layout, including the purpose and meth-

ods of many specific tests; Section II focuses on tests for adults while Section III reviews tests for children. Within these chapters, the authors have taken the extra step of detailing ordering information and cost of each instrument they describe. Finally, Section IV reviews special considerations relevant to various issues encountered in clinical practice including premorbid functioning, brain injured populations, patients with right hemisphere lesions, elderly, demented, and non-English speaking/bilingual patients.

This book has many applications, and most likely will be utilized slightly differently by scientists and practitioners at different stages of training and experience. Section I, the Introduction, contains several chapters with a broader scope than the topic of aphasia. As such, graduate students and beginning clinicians would find this a useful resource for a general review of fundamental principles of assessment, including test selection, diagnostic formulation, and effective delivery of consultation feedback to healthcare professionals. The book begins with an excellent review of clinical–neuroanatomic and psycholinguistic models of aphasia, which highlights the importance of using a conceptual model to guide assessment. Chapter 2 summarizes the history of aphasia assessment; chapter 3 discusses the purposes of an assessment. Again, this topic is broader than aphasia assessment alone and provides an excellent frame of reference for clinicians across disciplines. The authors differentiate screening exams from those designed to provide descriptive evaluations, to evaluate progress, and for functional/pragmatic assessments, reminding the clinician to frame the assessment around the nature of the referral question and to think globally in terms of the rationale and purpose of the assessment. After this first step in the assess-

ment process specific test selection can occur. Finally, chapter 4 is a brief review of “Test Construction 101,” summarizing issues of standardization, reliability, and validity. The presentation of this material is straight-forward and easy to understand, and is made more useful by the inclusion of relevant examples from tests of language functioning. This integrative presentation will aid the clinician in test selection and the budding researcher and test author in test construction. A detailed review of existing measures of language function follows.

Sections II and III are reminiscent of Spreen and Strauss (1998). Section II, which focuses on assessment of language function in adults, contains distinct chapters dedicated various goals of as well as constraints on assessment (e.g., bedside exam, comprehensive exam, tests of specific language behaviors, measures of functional communication). For each test, its history is provided, as are details about various normative samples and correlations with other measures and description of the method of test administration. For those tests not reviewed in detail, the authors provide references for the interested reader (e.g., the Action Naming Test). However, Spreen and Risser did not review tests that “have found little use in published studies” and no objective criteria were offered regarding how the authors determined “little use.” For example, despite more than 100 citations in peer reviewed research studies of language in children and adults, the Lindamood Auditory Conceptualization Test (LAC) was not given a full review. The reader may not agree with the authors’ perspective on which tests have significantly contributed to research on aphasia and language disorders.

Within the section of tests for adults, the authors devote chapter 8 to functional communication. They acknowledge and address the fact that social communication demands skills that are more complex and broad-based than those measured on tests of core language skills (e.g., naming, syntax, etc.). A patient could perform almost within normal limits during formal testing, but experience significant deficits in the real world; another may show tremendous gains on a given dependent variable over the course of treatment, but show no change in functional communicative capacity. These facts underscore the need for measures of functional communication and functional outcome to be included in language rehabilitation or remediation research.

Section III describes tests of language functioning appropriate for children, adolescents and teenagers. It begins with a general review of issues specific to testing of children with an emphasis on the complexities of developmentally appropriate tests and the importance of normative data. The authors note the differences between acquired versus developmental language disorders, but consider that most tests are appropriate for both etiologies: because of the inter-related development of substrates for higher-level language abilities, there may be more similarities between developmental and acquired language disorders than differences (Heilman & Alexander, 2003; Nadeau, 2001).

Finally, section IV reviews issues related to clinical assessment. Such considerations as premorbid functioning, attentional and motivational factors, and affective states/comorbid mood disorders, are addressed. Following this more global discussion, issues specific to the assessment of populations with unique features such as traumatic brain injury, right hemisphere damage, dementia, and bilingual or non-English language patients are addressed. Yet the authors fail to mention the importance of obtaining a thorough developmental history of language abilities for adults and children who acquire language disorders. As some aphasic adults may have had an undiagnosed language disorder in childhood, their developmental history could affect the interpretation of a language assessment and treatment plan for a mild or moderate aphasia. In this closing chapter on unique considerations for an aphasia assessment, the book comes full circle by closing with the reminder that selection of tests must be guided by the purpose of the assessment, and with the summary statement that clinicians must attend to current research on assessment instruments employed in practice.

Following Spreen and Risser’s elegant review of aphasia assessment, we turn to aphasia therapy. Basso’s goal is to connect aphasia research, practice, and therapy, a relationship she describes as “very loose.” She exhorts those in the scientific and clinical communities to work to bridge this gap and notes that while the book is intended mainly for clinicians, she also hopes to inform researchers about the process of therapy. However, because many researchers in aphasia are clinicians by training and practice, it would have been informative to know what aspects of the therapy process that Basso believed researchers have been neglecting.

The second goal of the book is to highlight past knowledge, as current knowledge is only as useful as our understanding of, and appreciation for, knowledge that has formed the foundation of today’s insights. In fact, the entire text is imbued with a sense of history from Ernest Auburtin’s 1861 address at the *Société d’Anthropologie de Paris* to the birth of cognitive psychology at the 1956 Symposium on Information Technology held at the Massachusetts Institute of Technology and through the works of Geschwind, Goodglass, and Kaplan in the 1970s.

The book is divided into three parts. Part 1 (chapters 1–4) reviews the first 100 years of aphasiology (e.g., history of aphasia, classification systems, aphasia rehabilitation, and aphasia therapy effectiveness), from World War II through the 1970’s. These chapters of the book provide valuable summary of theories of language rehabilitation which also considers limits to the aphasia literature from assessment and classification to rehabilitation. For example, Basso discusses implications of handedness, age and sex of the patient, etiology of the disorder, and time since onset, reviewing these issues in historical context and summaries of relevant reports. Chapter 3 provides an excellent discussion of techniques of aphasia therapy, organized by

underlying theoretical approach. Finally, in chapter 4, Basso tackles treatment efficacy but does not directly address treatment outcome measures, a topic that is relevant to studies of language rehabilitation and is particularly salient for establishing treatment efficacy. Nonetheless, this chapter goes a long way toward highlighting the importance of efficacy research in aphasia.

Part 2 (chapters 5–7) centers on cognitive neuropsychology. Throughout this section of the book, Basso addresses complex and fundamental theoretical issues that are intimately linked to the study of language including the role of data from brain-injured persons for understanding normal language, modularity *vs.* universality assumptions of cognition, and the value of single case *vs.* group studies. This section of the book explains the cognitive neuropsychology of language, moving from basic components of language (e.g., phonemes–lexicons–semantics) to the implications of a cognitive perspective for language rehabilitation. These chapters are rich in providing models of language and aphasia and the more global concepts of cognitive neuropsychology, well illustrated with examples from disorders of speech and language.

Part 3 (chapters 8–10) addresses aphasia therapy including specific interventions at the word and sentence levels, and specific treatments for severe aphasias. At the outset of this section Basso proposes and discusses details of a theory of aphasia such as models of impairment, hypotheses about neural mechanisms of recovery, and theories of learning in brain damage. A few comments on *factors influencing recovery* are included. One notable omission is a discussion of premorbid/developmental language disorders. Also, Basso essentially dismisses the role of age as a factor in rehabilitation with the comment that few studies have examined this issue and those that have suggest issues such as age, handedness, and education do not play a significant role. However, there is reason to believe that age affects plasticity and patterns of recovery, as well as the possibility that lack of a differential outcome for various age groups reflects the shortcomings of the aphasia therapy and not the factor

of age. It is from this platform of theories on aphasia that she moves, in chapter 9, to specifics of language treatments, that is, “what to do in therapy.” In chapter 10, concerning severely impaired aphasia patients, Basso asserts that pragmatic approaches (i.e., teaching compensatory strategies to augment language use) are more appropriate than cognitive strategies (i.e., restoration of impaired language). This chapter provides an insightful of differences between a pragmatic and a cognitive approach to rehabilitation.

In her conclusion, Basso addresses neuroimaging studies, connectionist modeling, and issues related to the process of therapy. Altogether, this impressive work provides a much needed foundation for integrating clinical and research knowledge. It is a thought-provoking and timely work, especially as our understanding of neural plasticity expands.

Together, these two books make a tremendous contribution to the field of aphasiology, as they directly aid in the quest to achieve better diagnosis and treatment for patients with aphasia. Although successfully teaching patients how to compensate for language deficits can improve the quality of life, the ultimate goal of rehabilitation is to find ways to restore impaired language abilities. Spreen, Risser, and Basso have clearly dedicated their significant energies and passion toward achievement of this goal in producing texts that will inform, and hopefully inspire the field.

REFERENCES

- Heilman, K.M. & Alexander, A.W. (2003). Developmental language disorders. In J.H. Noseworthy (Vol. Ed.), *Neurological therapeutics: Principles and practice*, Vol. 2. (pp. 2751–2767). New York: Allyn & Francis.
- Lindamood, P.C. & Lindamood, P. (2004). *Lindamood Auditory Conceptualization Test—Third Edition*. Austin, TX: Pro-ed.
- Nadeau, S. (2001). Phonology: A review and proposals from a connectionist perspective. *Brain and Language*, 79, 511–579.
- Spreen, O. & Strauss, E. (1998). *A compendium of neuropsychological tests. Administration, norms, and commentary* (2nd ed.). New York: Oxford University Press.

A Factor Analytic Approach to the WAIS–III and WMS–III

DOI: 10.1017/S1355617704221075

Clinical Interpretation of the WAIS–III and WMS–III. D.S. Tulsky, D.H. Saklofske, G.J. Chelune, R.K. Heaton, R.J. Ivnik, R. Bornstein, A. Prifitera, and M.F. Ledbetter (Eds.). 2003. Amsterdam: Academic Press. 618 pp., \$75.00.

Reviewed by W. GARY SNOW, Ph.D., *Private Practice, Toronto, Canada*.

This is an edited collection of papers that focuses on various aspects of the most recent revision of the Wechsler

Adult Intelligence Scale (WAIS–III) and Wechsler Memory Scale (WMS–III). The papers in this volume fall into

three broad areas. The first section of the book (and part of one of the subsequent chapters) provides an overview of the history of the development of measures of memory and intelligence, with particular emphasis on the Wechsler scales. These chapters are thoroughly delightful, and the only shortcoming is that they are too brief. Indeed, though over 100 pages are devoted to this topic, there are a number of questions about the measures which could have been answered but weren't. (For example, given the cost and time pressures on psychological assessment, why were the tests—particularly the WMS-III—lengthened? Why, for example, include a measure of list learning when Psychological Corporation already published the California Verbal Learning Test? Why, after all these years, hasn't the WAIS Information subtest been dropped or the content made less specific to the United States? What led to the decision to include a verbally mediated measure of visual memory on the WMS-III, a decision which can make it harder to evaluate visual memory in aphasics?) Given how involved they were in the revisions of the WAIS and WMS, the editors would appear to have been uniquely positioned to provide a more in-depth discussion of the issues that arose during this process and how these issues were resolved.

The chapters in the final section of the book focus on clinically relevant topics such as assessment of populations with specific disabilities, assessment of non-native English speakers, and how to train others in the administration of the tests. Much of this material will be familiar to experienced clinicians, but these chapters would serve as a useful adjunct to any graduate-level testing course. (Indeed one of the particular additional strengths of this book is that it is a rich source of topics for dissertation research).

The heart of the book is the middle section, which focuses on a specific, factor-analytically based approach to test interpretation. (Hence, the title of the book is somewhat misleading. It is not, strictly speaking, about the clinical interpretation of either the WAIS-III or the WMS-III, but primarily about a modification to the traditional index structure.) Part of the impetus for the development of the present model appears to stem from an error discovered in the original factor analysis of the WMS-III. Though the original factor analysis suggested a five-factor model, reanalysis indicated that a three-factor model accurately represented the factor structure of the WMS-III. Building in part on this work, and with some apparent influence from the Mayo Older Americans Normative Studies, the present book devotes much of its attention to a six-factor model for the combination of the WAIS and WMS subtests: the Verbal Comprehension, Perceptual Organization, and Processing Speed Index Scores from the WAIS-III, the Working Memory Index from the WMS-III, and two new Memory Index Scores (Auditory and Visual Memory Composite Index Scores). Because the six-factor model yielded no separate factor for delayed recall—either verbal or visual, the authors have grafted on what appear to be some ad hoc indexes in an attempt to allow a separate analysis of delayed verbal and visual recall.

Having developed the model in chapter 4, the authors then provide useful additional information about demographic corrections, base rates of discrepancy scores, diagnostic utility, and reliable change scores in subsequent chapters. They also discuss the effects on the factor structures of substituting or omitting some subtests.

A book review cannot do justice to this model, nor can it cover all of the complexities of the analyses undertaken by the authors. One obvious potential benefit of the six-factor model is that it permits assessment of each of the key Index scores with fewer total tests (and test time) than does administration of the complete WAIS/WMS. This benefit is not without cost, however. For example, Arithmetic (which has, perhaps, more ecological relevance than some subtests) is optional. Similarly, Digit Span, which can be used for assessing effort as well as attention, is also optional. In addition, while decreasing the number of tests required for mapping the cognitive domains of relevance, the psychologist's computational burden is increased, since the new Memory Indexes are not included in the current version of Psychological Corporation's scoring software.

The proposed model also suffers from one of the typical drawbacks of factor analysis—focus on the statistical with little emphasis on the practical. For example, while some neuropsychologists are still interested in making inferences about localization of damage the present work is largely silent on that issue. There is a chapter on the diagnostic utility of the new model, but the data presented concentrates on the diagnostic groups presented in the test manual. (Given how small—and selective—the patient samples in the manual are, it is hard to demonstrate whether the six-factor model is superior to the traditional approach). Finally, it remains to be determined if the present model will represent a significant improvement over the approaches we are currently using when it comes to predicting behavior in the real world. Indeed, once we have accounted for the predictions we can make on the basis of *g*, how much benefit do we get out of the data from any of the other factors?

Ultimately, the utility of the six-factor model will depend on whether it answers questions more expeditiously than the full WAIS-III/WMS-III and more thoroughly than the Wechsler Abbreviated Scale of Intelligence (WASI) and the Wechsler Memory Scale-Abbreviated (WMS-III-A). The model deserves further consideration and one can only hope that the Psychological Corporation will expedite the necessary modifications to the scoring software to permit interested psychologists to compare this model with the current Index and IQ scores.

As a final comment, although much of this book focuses on one particular approach to organizing the data from the WAIS and WMS, these chapters deal with larger issues which are not specific to the six-factor model. A reader who is satisfied with the current Index and IQ scores will nevertheless find much that is thought-provoking, clinically useful, and insightful.

Everything You Wanted to Know About Sex Differences, but Were Afraid to Be Perceived as Politically Incorrect

DOI: 10.1017/S1355617704231071

Brain Gender, by M. Hines. 2004. New York: Oxford University Press. 307 pp., \$49.50.

Reviewed by JEANNETTE MCGLONE, Ph.D., *Department of Psychology, Dalhousie University, Halifax, Nova Scotia, Canada*

Hines finds it impossible to make distinctions between the terms “sex” and “gender,” hence their refreshing, non-political interchangeability in her new book. After examining hormonal and brain-based data, Hines concludes that science cannot yet inform us which differences are determined biologically, socially, and/or both.

Chapter 1 launches into a summary of sex differences in human behavior, cognition, and laterality. She defines the term “difference” as one that is found *on the average* for males and females. Where available, she refers to the magnitude of difference based on meta-analyses “*d*.” This statistic allows the reader to contextualize the fact that cognitive differences between males and females are relatively small (i.e., less than 1 *SD*), amounting to about 1/11th the size of height differences, for example. Secondly, Hines proceeds to clarify that broad labels such as visuospatial or verbal abilities obscure sex differences that manifest reliably only on very specific tasks such as 3-D mental rotation or verbal fluency, respectively. Chapter 2 outlines the biological determinants of internal and external genitalia. The role of chromosomes and gonadal hormones in normal and abnormal development of physical appearance relevant to sexual reproduction in humans is reviewed. Chapter 3 addresses sexual differentiation in reproductive behaviors derived from experimental manipulation of gonadal steroids in rats, with the caution that primates and humans show similar, but not identical biological influences. The author presents data demonstrating that masculinity and femininity are two separate dimensions of reproductive behaviors. The conclusion that “no hormone can be thought of as exclusively female or male” will surprise some. Chapter 4 enumerates sex differences in size and shape of rat brains, as well as provides interesting chronological developments in animal research over the past 50 years.

We must wait until chapter 10 for a less cohesive presentation of sex differences in the human brain. There we learn that some of the subcortical structures found to be sexually dimorphic in animal models have human analogues, but that the functional nature of those structures are either unclear or show no sexual variability! Hines concluded that “few data are available linking structural sex differences to functional sex differences” (p. 211). She opines that methodological variation may be the culprit for a lack of consistency across human studies. There is a

brief section on imaging (i.e., PET, MRI and fMRI technology) to add excitement and complexity to the issues. A recurring theme of the book seems to be the unmasking of popularized schemas, outdated theories, and myths fossilized in textbooks without sufficient empirical support (i.e., testosterone causes aggression in adults, sex differences in cognition are dependent upon sexual variation in the lateralization of brain functions).

A major strength of the book is its virtual compendium of hormonal influences (i.e., androgens and estrogens) on animal and human behaviors displayed by males and females in prenatal, neonatal, and pubertal surges, during periodic hormonal fluctuations in adulthood, as a result of experimental manipulation, and disorders of nature. Large numbers of publications have been synthesized to answer certain questions. An extensive glossary helps those less technically fluent. The influence of gonadal hormones on human sexuality (e.g., sexual identity, orientation, and libido), play, aggression, parenting, and finally on cognition appears in chapters 5, 6, 7, 8, and 9, respectively. While gonadal hormones clearly influence sexual differentiation of the first four behaviors (at least in one sex), Hines thinks that cognition may be the exception to the rule. Many neuropsychologists will appreciate that double-blind, placebo controlled and randomized designs are rare in this field. All agree that rigorous methodology is essential to test cognitive theories postulating hormonally causative factors on cognition. For example, the enhanced functioning postulated for estrogen and progestin replacement in postmenopausal women based on the early literature, was not supported by a recent controlled study in women over the age of 65 who may be, in turn, at a higher risk of dementia (Shumaker et al., 2003)!

Hines remains open minded to all methods of study, appropriately critical of poorly designed publications or unreplicated findings, and includes a few key studies highlighting environmental/cultural influences on gender differences. She sees reason to continue research, while generously offering insightful hypotheses to test the biological influences on brain organization of sexually diverse development in humans. However, it is clear that Hines is not convinced that the extant body of hormonal and brain research has proven to have major causative effects on human cognition or brain organization. Any single-

authored text contains the writer's perspective, and this seasoned expert is no exception.

The book is not intended to be exhaustive, but rather it provides a scholarly synthesis of Hines' interests over the past 25 years. It serves as an excellent text for senior undergrad or graduate level courses on this topic. The final chapter, "Engendering the Brain," cautiously offers empirically supported advice for clinicians who counsel families on sex assignment of babies born with ambiguous internal or external genitalia. Hines also musters several thoughtful arguments and data sets challenging the notions that brain engendered differences in cognitive abilities explain the male predominance in occupations like science and engineering,

that sex differences in promiscuity (i.e., number of partners) are hormonally determined, and that testosterone makes men aggressive or limits their ability to nurture. She does a good job convincing us that the answers will be more complex than our original theories.

REFERENCE

Shumaker, S.A., Legault, C., Rapp, S.R., & Thal, L. (2003). Estrogen plus progestin and the incidence of dementia and mild cognitive impairment in postmenopausal women. *Journal of the American Medical Association*, 289, 2651–2662.

Probability and the Single Neuron

DOI: 10.1017/S1355617704241078

Decisions, Uncertainty and the Brain: The Science of Neuroeconomics, by P.-W. Glimcher. 2003. Cambridge, MA: MIT Press. 375 pp., \$40.00.

Reviewed by M. KINSBOURNE, M.D., *Dept. of Psychology, New School University, New York, NY.*

WHY NEUROECONOMICS?

In an uncertain world, people and other animals make their living by predicting which of alternative courses of action is likely to yield the best return. For humans the return might take many forms, such as material, financial, social, or esthetic, but the underlying currency involved for any species is "inclusive fitness," the rate at which an animal's genes are propagated. Professor Glimcher demonstrates that Economics methods are applicable to decision-making under conditions of uncertainty, both at the behavioral and the neuronal level. This approach has been called neuroeconomics, although "econometrics" characterizes it more precisely. Econometrics is the application of statistical and mathematical methods in the field of economics to test and quantify economic theories and the solution to economic problems. Specifically, individuals' decision-making benefits from knowing how likely a response is to be reinforced, and knowing the reinforcement's value. Even single neurons are sensitive to these variables. Glimcher reaches beyond the heavily studied neural substrate for sensation and response to predictive neural circuitry that factors in the prior probability of reward, and its expected value. Indeed, he and his colleagues have identified neurons in monkey's inferior parietal lobule whose firing rates reflect both probability and value.

Glimcher argues that all behavior is indeterminate, the outcome of decisions based on a reckoning of probabilities, whether conscious or not. Determinate machine-like reflex responses such as are elicited from the isolated spinal cord are not in the repertoire of intact individuals. Formally, a

system is considered determinate if, when one isolates it and repeatedly imposes identical starting conditions, its behavior is the same every time. Machinery is the obvious instance, but even ostensibly random outcomes such as occur during coin-flipping have been found to be determinate if the starting conditions are precisely identical. In intact biological systems starting conditions can probably never be held completely constant. So whether any behaviors are strictly speaking determinate is moot anyway. But this is not critical to Glimcher's argument that what animals do is not machine-like, but based on probabilities. Adapting the words of Stephen J. Gould, if one could rewind the tape of a life and let events play out again, the results would almost certainly differ dramatically.

SECOND GUESSING THE PAST

Blame the usual suspect, René Descartes, for the reductive approach. He grasped the machine-like nature of human behavior, but avoided attributing all of human existence to gross matter by regarding the will as a product of the soul, the brain conveying its instructions to the body. Did he really believe in this dualistic dichotomy, or did he present it to safeguard himself from charges of heresy? Either way, he has led neuroscientists up a garden path ever since. Cartesian dualism became a favorite means for kicking currently insoluble problems upstairs.

Such impoverished systems as the isolated spinal cord are used precisely because they react more predictably, being free of less controllable top-down influences. The result

suggests a functional anatomy, but does not purport to represent functioning that occurs autonomously in the intact individual. In so far as findings from the isolated spinal cord have been extrapolated to parts of the brain not yet understood, this strategy succeeds if the system as a whole uses the same building blocks as the part studied. It fails if, as Glimcher believes, the very act of reduction has changed the manner in which the system works, throwing out the baby with the bathwater. Whereas Sherrington hedged his bets about extending his reflex model of behavior, no less an investigator than Pavlov believed that his findings on cortical reflexes are applicable to the more complex behaviors. Others treat behaviors that appear to be indeterminate as distinct from behaviors that characterize “man as machine,” attributing them to a qualitatively different non-biological source, such as the soul, or instruction direct from God. Glimcher believes that he has a better theory, and one that can be empirically validated. Having demolished reflexology at length in 10 entertaining as well as informative chapters on the history of neuroscience, he propagandizes theoretical advances in mathematics and evolutionary theory. In the final three chapters he presents illustrative experiments from his own laboratory both on the whole individual and the single neuron.

Critics as gifted and articulate as Hughlings Jackson, Henry Head, Paul Schilder, Kurt Goldstein, and Heinz Werner, protested that the intact brain functions along quite different lines from truncated parts of the nervous system. But they could not convincingly support their global theories empirically, because the technologies required to test their claims experimentally were not yet in place. Scientists are conservative. Kuhn remarked that a theory will not be rejected simply because it is inadequate, but only if it is confronted by a better one. So, although few neuroscientists would deny that the bottom-up reflex approach was ultimately inadequate, they continued to adhere to it for want of a testable better model. The necessary technologies are now available, but the theorizing has lagged behind. The new wine of technological advance has been poured into antiquated bottles of theory. Even Glimcher’s neuroeconomic approach falls far short of what the holistic theorists would have considered an adequate account of behavior.

ECOLOGICAL VALIDITY OF PROBABILITY THEORY

Having introduced Von Neumann’s *game theory*, Glimcher explains why it behooves animals to behave unpredictably. Animals make a living out of predicting what will happen next. What happens depends not only on physical circumstances, but also on the motives of other animals, predators and prey. Unpredictable behavior by prey frustrates the predator’s anticipations. For humans, so intensely social, the biggest challenge is to predict what other humans will do. This entails resort to probability theory. Glimcher claims that probability theory can clarify behavior at all levels. Questions remain, however. It is not clear how probability

theory clarifies simple or automatic behavior. Moreover, Glimcher’s discussion of strategic behavior omits emotion as an intervening variable and smacks of the behaviorist. Glimcher does concede that mind is possible, but doubts its relevance: “mind, though it may very much exist, simply does not figure in that equation” (p. 343), he writes, referring to the neuroeconomic brain–behavior architecture. Other neuroeconomists do include emotions in their theoretical framework.

We can extend the analysis to the world outside the laboratory, where multiple opportunities exist for responses that are potentially rewarded. What happens when two responses offer equal probability of reward, of equal value, as they did to Buridan’s hypothetical Ass? Jean Buridan, fourteenth century philosopher of mind and Rector of the University of Paris, devised this thought experiment. Or perhaps an adversary devised it, in order to make an ass out of Rector Buridan. I contributed the predator.

GAMES DONKEYS PLAY

A hungry ass finds himself equidistant to two piles of hay, one right and one left, which are equal in size as well as quality. Having no reason to prefer one pile to the other, the ass cannot decide which pile to eat first. Relentlessly rational, he stays in place and starves to death.

A predator lurks nearby. He wants to intercept the ass’s path to dinner, and make dinner out of the ass. However, he does not know which path that will be. He seeks a clue on which to base a prediction.

What would an actual ass do, faced with an approach–approach conflict between heading right and heading left, while keeping his intention inscrutable? The response conflict is within an opponent processing system that consists of a right-turn vector represented in the left brain, and an equally activated left-turn vector in the right brain. However, the equilibrium between right and left turning tendencies is unstable.

The cerebrum houses 10^{11} neurons, making 10^{14} synaptic connections, all firing all the time. Most of this activity is autonomous, and not in response to stimuli whether external or internal in origin. Such intense ongoing traffic in a totally connected network guarantees moment-to-moment fluctuations of the activation levels. If one representation gains a momentary edge, it will increase its inhibitory hold on the other, which consequently will diminish the other’s inhibitory hold on it. The momentary disparity will suffice to swing intention to one of the two trajectories, in a rapidly enlarging activation imbalance, like a seesaw tipping to one side. Two adaptively advantageous outcomes result from this non-rational randomly generated difference-amplifying feedback. The animal gets to eat. Since the outcome is randomly determined, the predator has no basis for predicting it. I intend this illustration to suggest that animals do not need a random sequence generator in order to behave randomly. Randomness is inherent in the “noisy” neural network.

WHAT DOES THIS BOOK OFFER THE NEUROPSYCHOLOGIST?

It offers the company of an educated mind on a short trot through seldom encountered domains of knowledge. The reader is unlikely to find elsewhere as clear and readable an exposition of topical issues such as Nash Equilibrium or Prey Theory. The book is not a compendium of neuroeconomics, however, but intensely personal. Glimcher's references to neuropsychology are rudimentary. But the decision mechanisms that Glimcher studies at the behavioral and the neuronal level could be identified in patients with brain lesions, especially of prefrontal cortex. A significant literature on decision making under conditions of uncertainty, not reviewed in *Neuroeconomics*, implicates ventromedial prefrontal and left inferior parietal cortex, as well as lateral cerebellum. Whatever an animal can do must derive from the activity of specific brain circuitry, and therefore must be reflected in the activity of individual neurons within the

circuit. Hence probabilities are reflected in the firing of the single neuron. Finding such neurons is fascinating, but not revolutionary.

CONCLUSION

Glimcher makes no effort to be comprehensive in his account of neuroeconomics, and refers to few recent studies other than from his own laboratory. Instead, his purpose is to establish a theoretical underpinning for recent experiments on behavior under uncertain conditions that are scattered in the literature. Some readers might find Glimcher's spirited arguments for the revolutionary significance of probabilistic reasoning to neuroscience theory persuasive. Personally, I doubt that neuroeconomics is a watershed for neuroscience or paradigm shift. I do believe that it enriches the limited existing treasury of theory in contemporary neuroscience. Its hyperbole should be no deterrent to reading this intriguing, coherent and informative book.