Essay/Book review to appear in *The Gerontologist*

VISION IMPAIRMENT AND REHABILITATION: TAKING STOCK AND LOOKING AHEAD

Vision Loss in an Aging Society: A Multidisciplinary Perspective, edited by John E. Crews and Frank J. Whittington. AFB Press, New York, 285 pp., $32.95 (paper).

Vision Rehabilitation: Assessment, Intervention and Outcomes, edited by Cynthia Stuen, Aries Arditi, Amy Horowitz, Mary Ann Lang, Bruce Rosenthal, and Karen R. Seidman. Swets & Zeitlinger Publishers, Lisse, The Netherlands, 2000. 952 pp., $199.50 (cloth).

The Lighthouse Handbook on Vision Impairment and Vision Rehabilitation, Volume I, Vision Impairment, and Volume II, Vision Rehabilitation, edited by Barbara Silverstone, Mary Ann Lang, Bruce Rosenthal, and Eleanor E. Faye. Oxford University Press, New York, 2000, 1,396 pp., $275.00 (cloth), also available on a CD-ROM, free to visually impaired purchasers of the print edition.

Homo sapiens are visual creatures. Thanks to the adaptations and lifestyles pioneered by our non-human primate ancestors, human culture and human activities today revolve around seeing. To quell any lingering doubts about this assertion, one has only to consider contemporary studies that map out the functional geography of the cerebral cortex. Those of us with a professional interest in vision take quiet pleasure in that vast neural real estate the human brain normally devotes to seeing.

But vision's importance in ordinary, everyday life is equaled by the complexity of the neural computations upon which seeing depends, and by the fragility of the complex machinery out of which its products arise. Sure, that machinery has numerous protective devices, such as the anti-bacterial agents in the fluid that normally bathes the cornea, the ample cushion of shock-absorbing fat that surrounds each eyeball, and the mechanisms that remove and recycle used outer segments of photoreceptor. But, like any complex machinery fabricated by unskilled labor using cheap material, the human eye and brain -- for seeing is as much the creation of the brain as it is of the eye -- are vulnerable to various slings and arrows. All sorts of things can go wrong, and often more than one does. These include genetic errors that subvert the eye's optical or neural properties; a host of different processes that usually accompany "normal" aging; and the

myriad diseases, well known as well as obscure, that can undermine vision, directly or indirectly. Any or all of these can produce a functional vision impairment, which the editors of *The Lighthouse Handbook on Vision Impairment and Vision Rehabilitation*, Barbara Silverstone et al., define as a limit on vision that "prevents, or causes difficulty in, performing tasks typically part of daily activities" (p. xvii). This emphasis on vision's role in daily activities echoes the recognition during the last two decades that good vision is not merely a medical issue; it is equally an issue of the quality of everyday life, particularly for the older members of any society.

Volume I of *The Lighthouse Handbook* presents a balanced, if abbreviated, treatment of visual impairment. Readers with particular interests in visual impairment of the young or the old will find much useful material here. The chapters, which vary greatly in style and length, are supplemented by a generous number of references that are keys to further reading. Volume II of the *Handbook* devotes itself to issues and practice of rehabilitation (and, in the case of children, habilitation). The formulation and delivery of vision-centered rehabilitation involves a great many providers and agencies that do heroic and valuable service, usually making do with fewer resources than the job really requires. As understood today, vision rehabilitation focuses not just on the visual system, but also on how vision is used. This larger view encompasses the characteristics of the visual environment, for example proper signage, architectural assists to wayfinding, and techniques for producing and delivering visually-enhanced images and documents. Equally important is the design of electronic tools for work, such as computer screens, cellphones, and personal digital assistants.

Once upon time, actually not that long ago, vision rehabilitation was largely a matter of prescribing optical devices such as handheld or stand magnifiers, or monocular telescopes. Such devices, and others, can offer increased independence and quality of life. But various obstacles to their convenient and effective use causes untold numbers of such devices to end up unused and abandoned in drawers. For one thing, the prescription of assistive devices requires that a profound understanding of the client, how he or she lives and works, what the client's aspirations and goals are, and how well the client is prepared for change.

The *Handbook's* chapters on assistive devices for the blind and for people with low vision tend to take a measured and realistic view. They recognize that, no matter how valuable an assistive device seems to its inventor, that alone does not guarantee the device will be accepted and used. Social, financial, cultural, and family factors influence whether individuals

will actually use the technology. Most assistive technologies usually require sustained effort and adjustment, fine-tuning to the individual's changing circumstances and needs. This is true for devices of all sorts, ranging from an inexpensive handheld magnifier to a sophisticated, computer-based system for enhancing video images. Joan Chase, a contributor to the *Handbook*, makes the excellent point that "Technology is valuable only when employed, and best when employed enthusiastically. People vary greatly in their enthusiasm for novelty and in their approach to solving life problems in new ways" (p. 983).

My professional interest in vision and aging made me especially eager to read the *Handbook's* section on "Rehabilitation of Older Adults with Vision Impairment." Priscilla Rogers and Alberta Orr, the authors of one chapter in that section, are right to say that demographics dictate a need for more people and more resources to address the rehabilitation of older adults with functional vision problems. About that there's no debate. But their discussion of research is limited to need for better data -- about outcomes, and about the population that could benefit from service delivery. Sure, such data are needed, particularly now, when demands for accountability are paralleled by growing needs that outstrip available resources. But nowhere in this section or in the other discussions of rehabilitation did I find mention of novel rehabilitative approaches that would be grounded in neuroscience. Let me explain what I have in mind.

In the United States, the twentieth century was capped by the Decade of the Brain, a high-profile national effort to stimulate research into all aspects of the nervous system. This effort, which spanned the gamut of modern neuroscience, produced many exciting discoveries, including some that could be exploited in vision rehabilitation. The Decade of the Brain left us with a new appreciation for the nervous system's plasticity. For example, we know that congenital blindness fosters a significant reorganization of the brain. Functional neuroimaging of congenitally blind individuals shows that a portion of the vast cerebral territory ordinarily devoted to processing visual input is commandeered. These areas with altered allegiance process tactile inputs, such as are generated while reading Braille (Sadato, Pascual-Leone, Grafman, Ibanez, Deiber, Dold & Hallett, 1996). This reorganization in the congenitally blind is nothing short of astonishing; it requires shifting neural pathways by many centimeters, which, in brain terms, can be likened to the distance between Boston and Washington, D. C.

But it's not just the immature, developing brain that responds adaptively to altered circumstances. Recent research, particularly on the brain's sensory and motor systems, reveals a breathtaking and unexpected plasticity. In both human and non-human primates, systematic, systematic practice in making particular sensory discriminations -- say, between two highly similar tones -- alters the brain and improves sensory acuity. The regimen is especially effective if the difficulty of the task is adjusted to the participant's own capacity, starting with a relatively easy discrimination and gradually ratcheting up task difficulty. This result from basic research on non-human primates has been expanded for use with human children who have a sensory-based language learning disorder (Tallal, Merzenich, Miller, & Jenkins 1998a, 1998b). This systematic, graded training procedure has been embodied in a computer game, which is now used in many school systems throughout the United States. An analogous, systematic training regimen has been used with considerable success with stroke patients who have hemiparesis (Taub, Uswatte, & Pidikiti, 1999). Again, functional neuroimaging shows that improvement in the use of the paretic limb is accompanied by -- or follows? -- a reorganization of the brain. Here, the reorganization involves a reassignment of neural responsibilities within the motor region of the brain (Liepert, Bauder, Wolfgang, Miltner, Taub, & Weiller, 2000). This miraculous restoration of function has a cost. It seems to require arduous training over many hours each day. This may rule out use with all but the most highly-motivated stroke patients.

Systematic training can also alter some elementary visual functions. Take an example. With experimental participants 70 to 80 years old, Ball & Sekuler (1986) showed that ability to discriminate between two similar directions of motion is quickly and significantly improved. A week of daily practice on this task made the average 70-80 year old the equal, in direction discrimination, to the average untrained, young participant, about 20 years old. This improvement was retained without further practice until the experiment was terminated weeks later. Similarly, Sekuler & Ball (1986) demonstrated a practice-induced expansion of old participants' useful field of view.

Building on a new appreciation of the adult brain's plasticity, recent research suggests the possibility of reversing partial blindness, such as the visual field defects that follow optic nerve or brain injury (Kasten, Wust, Behrens-Baumann, & Sabel, 1998); Sabel, & Kasten, 2000). A key to this rehabilitative effort is high-resolution testing of the patient's visual field. This unusual detailed visual field testing identifies any areas of residual vision. (If there are no such

areas, the technique cannot be applied.) Once a small area of residual vision is identified, repetitive stimulation of that area gradually enlarges that spared area. The average result is an expansion of about 5 degrees -- the margin of the newly-expanded region of vision shifted by about 5 degrees visual angle. To appreciate the magnitude and potential usefulness of such an expansion, one should realize that it is equivalent to 2.5 times the width of one's thumb when that thumb is held at arm's length. This is big. Although coordinate studies with functional neuroimaging have not yet been done, there is every reason to believe that this partial restoration of vision reflects some plasticity in brain circuitry. Clearly, research of this kind could represent an important addition to the various techniques already employed in vision rehabilitation. To say that more research is needed on these promising avenues for rehabilitation would merely belabor the obvious.

Returning to the volumes that are the occasion for this essay, John E. Crews and Frank J. Whitington, in *Vision Loss in an Aging Society: A Multidisciplinary Perspective*, have edited a useful, non-technical collection of chapters that approach age-related vision loss from a multitude of perspectives. This book's large, clear print, and ample white space, show that its publisher (the American Foundation for the Blind) understands issues of accessibility. In addition to a discussion of the medical issues surrounding age-related vision impairment, Crews and Whittington's book provides an excellent, up-to-date treatment of the demographics of age-related vision impairment, and of the social policy issues related to vision and aging. I especially recommend a chapter by Bryan Kemp that firmly places vision rehabilitation in its full psychosocial context. That chapter is a superb companion to Barbara Silverstone's wise treatment, in Crews' and Whittington's book, of the family's crucial role in the ultimate success of rehabilitative efforts with older, visually-impaired adults.

To conclude on a sour note, let me comment on one other volume, *Vision Rehabilitation: Assessment, Intervention and Outcomes*, edited by Cynthia Stuen et al.. This book is the product of a conference on low vision held at the Lighthouse in New York in July 1999. The preface tells us that the conference included more than 760 presentations, and explains that this volume attempts to reflect the diversity of the presentations, the conference, and the field. Like so many conference proceedings, particularly conferences with hundreds of participants, these proceedings could have benefited from a far stronger editorial hand, and an organizing principle beyond the mere reflection of a conference's diversity. The result of these failures is not so

much a useful book as it is a sampler comprising over 220 short pieces. And no matter how central a piece's topic may be to the field, or how much its author may have to contribute, most pieces are just 3-4 pages long, just barely more than abstracts. Ordinarily, I resonate to Polonius' advice that brevity is the soul of wit, but the brevity in these conference proceedings is hardly a virtue if one is looking for genuine substance. To make matters worse, more pieces than one would like are entirely lacking citations to the relevant literature. This inexcusable omission forecloses the possibility that a reader could easily learn more about some topic of interest, except by contacting an author. Fortunately, each author's surface mail address is given; unfortunately, very few e-mail addresses are provided. The volume does introduce a few important topics omitted in *The Lighthouse Handbook,* for example Charles Bonnet syndrome, but I cannot recommend it as a reference source, particularly given its cost. In my view, this sort of collection did not belong between expensive hard covers. Like many conference proceedings, this one warranted publication on the Internet, a less formal, but more accessible format.

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