UCSF
UC San Francisco Previously Published Works

Title
A Commentary on “Disconnexion Syndromes in Animals and Man”

Permalink
https://escholarship.org/uc/item/6gj4v8t2

Journal
Neuropsychology Review, 20(2)

ISSN
1573-6660

Author
Miller, Bruce L.

Publication Date
2010-06-01

DOI
10.1007/s11065-010-9133-y

Peer reviewed

eScholarship.org Powered by the California Digital Library
University of California

Neuropsychol Rev (2010) 20:126–127
DOI 10.1007/s11065-010-9133-y

A Commentary on "Disconnexion Syndromes in Animals and Man"

Bruce L. Miller

Published online: 26 May 2010
© The Author(s) 2010. This article is published with open access at Springerlink.com

"Disconnexion syndromes in animals and man, Part 1" represents one of Norman Geschwind's most important papers, an article densely rich in detail and one that trumpets a modern approach to understanding of the brain. It is a comprehensive analysis of the visual system with extensive discussion of how non-human primates and man process visual information. The article emphasizes the role of white matter tracts that project to and from different brain regions in the generation of specific behaviors. Although Dr. Geschwind focuses on the white matter tracts in the brain, this article is an amazingly rich description of how the cortex is organized for visual processing at an anatomical and physiological level. At least from an intellectual perspective, it put to rest forever the holistic approaches to cortical function that had been in vogue for three-quarters of a century. Written more than 45 years ago, the article foreshadows work that is just beginning today, focused around the MRI techniques of diffusion tensor imaging, diffusion-weighted imaging, and functional connectivity mapping. Thinking backwards it is hard to imagine that anyone could have objected to the concepts put forward in this article, yet at the time, Dr. Geschwind was ignored and even derided for his approach. Sadly, even today there is resistance to the study of cognitive function within the field of neurology, based in part upon residual mistrust of the idea that there are localized functions within the cortex.

B. L. Miller (✉)
Memory and Aging Center,
University of California- San Francisco,
San Francisco, CA 94143-1207, USA
e-mail: bmiller@memory.ucsf.edu

The article is divided into three parts: 1. "Anatomical Background: Flechsig's Rule," 2. "Agnosias in Animals," 3. "Disconnexion Syndromes in Man." Dr. Geschwind begins by describing the forgotten history of disconnection syndromes. He makes the simple yet seminal observation that white matter is necessary for conducting messages from one brain area to another. Dr. Geschwind was responsible for the reintroduction of the writings of Wernicke and Broca to modern neurology, and he credits them for the idea that specific brain regions have distinctive functions. He notes that Wernicke's description of conduction aphasia emphasizes how loss of a white matter connection from one brain region to another can lead to a specific language disorder. Dejerine's description of alexia without agraphia, a classical visual disconnection syndrome, is described and defended. Similarly, he notes the important work of Liepmann in delineating a disconnection form of pure word deafness. By the early twentieth century, Wernicke and Broca, Dejerine and Liepmann were being disparaged, like Geschwind, as diagram makers; a holistic approach to cortical function was underway. In this article, Dr. Geschwind notes that many of the critics of cortical localization, like Head, von Monakow and Goldstein, agreed fundamentally with the findings of their cortical localization predecessors. Yet, the influence of these critiques was so strong that cortical localization almost disappeared from neurology and neuropsychology.

In the section of his article on Fleschig, Geschwind notes, "Flechsig's principle states that the primary receptive areas (the koniocortices) have no direct neocortical connexions except with immediately adjacent, "parasensory" areas, the "association areas" of common neurological usage." This fundamental concept has profoundly influenced the way that modern cognitive neuroscience thinks about cortical localization. Dr. Geschwind's student, Marsel

Mesulam, has created an entire localization system based on the way that brain regions connect to other brain regions. The concept of primary, secondary and tertiary association cortices is all organized around white matter connections. Without the rediscovery of Flechsig's principle, it is hard to imagine how we would think about cortical localization.

The section on agnosias in animals is extraordinarily original, and Dr. Geschwind tackles the behavioral features of visual agnosia in a completely unique manner. He emphasizes the limbic fibres that connect to visual cortex, and he gives a remarkable explanation for why animals with anterior temporal lobectomy will touch snakes or place non-food items in their mouth, yet react appropriately to tactile stimulation: there is a disconnection between visual and limbic processing. Hence, the animal does not make an emotional connection to potentially toxic visual stimuli. The concept that reward is connected to cognitive function is remarkably modern, yet this powerful idea present in the 1965 paper has only recently been explored. Additionally, a theory of prefrontal cortex and its connection with specific modalities of memory is discussed, and Geschwind speculates that specific memory deficits emanating from a frontal lobe injury may be generated from disconnection of frontal hippocampal structures.

In the final section of Part I, "Disconnexion Syndromes in Man," Geschwind asks if there are higher order syndromes in humans that are based upon disconnection. He brings up the idea of "asymbolia to pain," a disorder first described by Schilder and Stengel, where individuals can detect sensory information but do not describe these inputs as painful. He suggests that disconnection between insular cortex and the tertiary parietal regions may explain this odd syndrome. Modern research suggests that the concept here is correct although the subjective experience of pain may go on in anterior insular regions, not parietal cortex. Finally, there is an extensive discussion of language in humans with great emphasis upon the supramarginal and angular gyri, brain regions that myelinate last.

One of the fundamental components of my training with Norman Geschwind's student, D. Frank Benson, was the idea that the angular gyrus, greatly evolved in human compared with non-human primates, is a tertiary association area, a brain region where secondary association areas for tactile, auditory and visual processing feed into. It is in the angular gyrus that reading, writing, arithmetic and naming are performed through cross-modal association. Wernicke's aphasia, pure word deafness, alexia without agraphia and tactile aphasia are all described with Geschwind's masterful knowledge of the medical literature and anatomy.

Norman Geschwind writes in a style that is not easy to understand. The prose is dense and references to anatomy are highly complex, sometimes perplexing even an experienced behavioral neurologist. Yet, there are few articles in neurology more influential or more important. It is humbling to reread the work of a genius, a genius who was strongly influenced by other brilliant thinkers of the time, particularly Paul Yakovlev, the great Russian anatomist. This work represents a powerful historical marker for the development of neurology in the 20th century. It is propelling all of our work, even today.

Open Access This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.