Margaret Semrud-Clikeman
Phyllis Anne Teeter Ellison

Child Neuropsychology

Assessment and Interventions for Neurodevelopmental Disorders

Second Edition

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Foreword

The human brain represents the product of an ongoing, six-billion-year construction project. In its physical form and function, the human brain represents millions upon millions of trial-and-error adaptive adjustments. Comprised of an estimated 100 billion neurons and many more glial cells it is organized into thousands of regions. The human brain, in a seamlessly integrated manner, governs body functions and movement but more importantly, regulates cognition. Not surprisingly, although the brains of different animals may not look exactly alike, they all work according to the same principles and mechanisms. These neurons and glial cells communicate using a nearly infinite number of synaptic connections, yet the entire organ in humans weighs only about three pounds. As authors Sandra Aamodt and Sam Wang eloquently describe in their book, *Welcome to your brain* (2007), billions of years of evolution have resulted in a very complex human brain, yet one that is a jumbled, far from efficient, crowded organ. They describe the neuronal pathways of the human brain as the equivalent of the New York City subway system or the streets of London with layers upon layers of routes each constructed at a different time in a different way. Yet this stunning system, for the most part, develops and works fine for most children.

The adult human brain at between 1300 and 1400 cm is by far not the largest brain among mammals. Consider that a sperm whale's brain is approximately 7800 cm and an elephant's brain is 4700 cm. Thus, bigger brains alone do not necessarily mean smarter or more developed organisms. Although larger brains are associated with higher intelligence to some extent, smaller brains can be advantageous from an evolutionary point of view, particularly if they are equal in intelligence to larger brains. But many additional factors beyond brain size impact intelligence. Brain size in vertebrates such as humans may relate more to social rather than mechanical skills. Lower ratios of brain to body mass may increase the amount of brain mass available for more complex cognitive tasks. For reptiles it is about 1:1500; for birds, 1:220; for most mammals, 1:180 and for humans, 1:50. MRI studies of humans have demonstrated that to some extent brain size has modest correlation with intelligence. Among our ancestors, homo erectus had a brain size of about 980 cm; homo habilis a brain of about 750 cm; homo floresiensis a brain size of about 380 cm; and neanderthals a brain size slightly larger than our current brains. Consider also that an infant is born with a brain of 300–400 cm tripling in size by the adult years. Yet, between birth and the conclusion of the first two decades of life, a nearly infinite acquisition of knowledge and behaviors characterizes human development. Gram for gram the human brain delivers an almost dazzling array of motoric, behavioral, cognitive and emotional capacities nearly impossible to fathom in light of its' size. The brain is a metabolically high cost organ consuming about 20% of the body's metabolic energy providing further evidence of its' complex operations. Further most energy use is devoted to being ready to think and respond rather than thinking per se.

Despite rapid and fascinating advances in our understanding of brain structure, function and complex human behavior, it still remains the case that there is much more that we don't know about how the brain grows, functions and ages. Though neuroimaging techniques have allowed scientists to appreciate the relationship between the anatomy and physiology of the brain and motor functions for example, the basic cognitive operations of the brain remain elusive.

Beyond anatomical structure and physiology, the brain unlike any other organ in the body creates an alter ego, the conscious mind. In his fictional short story *They're made out of meat,* author Terry Bison describes aliens with electronic brains referring to humans as "thinking meat"! The idea that the brain can create consciousness seems like a science fiction phenomena. For thousands of years philosophers and scientists have debated and waxed poetic about the nature of the human mind. The mind appears to be composed of a set of processes driven by language, organized by memory and individualized by each person's unique perception and interpretation of their lives. And yet, the human brain does not appear to possess a localized center of conscious control. Though highly dependent upon the frontal lobes, consciousness is also dependent upon sensory, processing and interpretative abilities distributed throughout the brain. A description of the biological basis of human consciousness continues to elude the best efforts of current researchers. We understand how people lose a sense of consciousness. We also understand how certain conditions are created by alterations in the brain and conscious experience. Yet as we come to appreciate and understand the relationship between certain conscious activities and structures within the brain, it still remains the case that our consciousness extends well beyond the structures and physiology of our brain.

In her extremely cogent and interesting book, *Brain dance* (2004), Dean Falk, a professor of anthropology at Florida State University, describes the conditions and circumstances that allowed a group of ape-like individuals to evolve over a period of at least 5 million years into homo sapiens. During this process, the brain became increasingly more specialized evolving a broad range of abilities as well as right-brain/left-brain and male/female differences. As Falk notes, in less than 2 million years, brain size doubled in the homo species, from around 650 to 1350 cm. Only a small portion of this newly evolved, larger brain was tied to increasing body size. As Falk points out, this process was unprecedented in the evolutionary histories of other mammals. As brain size increased, neurons enlarged and became more widely spaced and the cerebral cortex became more convoluted. As Falk notes, no new structures were found in these larger human brains. However these larger brains set the foundation for an accelerated evolutionary process never before witnessed in any earthbound, mammalian species. In this process, the pre-frontal cortex and the posterior areas of the brain associated with sensory processing in particular became especially convoluted. As Falk points out, the shift in neurochemicals, anatomy of neurons and brain function provided the underlying mechanics of our rapid evolutionary progression, a pattern that was most certainly driven by natural selection.

It is also the case that for hundreds of thousands if not millions of years our ancestors have developed a finely tuned capacity to respond emotionally to events in the environment leading neuronal pathways between emotive centers of the brain stem and cerebral motor control areas to be shorter than those connecting complex, cognitive areas in the frontal lobes. Though as human beings we still process the world first and foremost emotionally, we have developed an impressive capacity to think before acting on emotion alone. Yet it is still the case that stressful experiences may quickly override our capacity for rationale, reflective responding.

Finally, out of this amazing progression forward, we developed language. As Clive Bromhill writes in his book, *The eternal child* (2003), long after we developed the ability to walk on two legs and our brains became larger than those of any other species on the planet, we were still limited in our capacity for complex thinking. For a long period of time, our ancestors' brains grew larger but we appeared to reap few intellectual benefits. However, within the past 50,000 years something happened in the human brain that transformed the already large brains of our ancestors into what they are today. At some point, brain circuitry changed. Our human ancestors through the harnessing of language developed the ability to think. As Bromhall notes, the brain became partitioned, permitting the capacity for subjective experience. In other words, we can simultaneously experience internal thoughts and the external world, a key ingredient in consciousness.

As the center of our consciousness and being, it is fitting that we devote an increasing scientific literature to understanding and facilitating the operation of the developing brain; in particular an appreciation of the developmental disorders and conditions that adversely affect children's transition into adulthood. Children's brains represent an incredible capacity to learn. In the span of 18 months between 1 1/2 and 3 years of age for example, children move from not speaking to telling us how to live our lives! In bilingual homes they master two languages simultaneously.

Clinical child neuropsychologists today and in the future must be scientist practitioners. To do so effectively requires a special type of literature at our fingertips. The first edition of Clinical Child Neuropsychology provided such an essential resource. As research scientists the joint and individual work of Drs. Ann Teeter and Margaret Semrud-Clikeman over the past thirty years has greatly expanded the boundaries of brain neuroscience. I have had the exceptional opportunity to work professionally with both of them. In the second edition of this seminal work, Drs. Ann Teeter and Margaret Semrud-Clikeman have authored a number of new chapters, included case studies in all chapters and completely re-written and updated existing chapters. This volume seamlessly blends current knowledge in pediatric neuroscience with practical, reasoned and reasonable strategies to understand, evaluate and treat the myriad of neurodevelopmental problems children experience as they grow into adulthood. With great pleasure and admiration I will place this volume next to the first edition of this text on my bookshelf.

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