

Review: Subcortical Structures and Cognition: Implications for Neuropsychological Assessment
LK Koziol and DE Budding
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One of the main concepts presented within this book is that the basal ganglia play a central role in adaptation. They do this by serving as a “gate” of sorts that “decides” when to release predominantly subcortically mediated, automatic behaviors in the context of familiar and over learned situations, in which case releasing such behaviors is efficient and effective. On the other hand, they “decide” not to release such behaviors in favor of opening channels for cortically based, higher level reasoning in the context of circumstances that are novel. It is much more economical to do what is familiar, as cortical resources are at a premium and employing them requires cognitive effort. By the same token, if one employs overlearned responses in the context of a situation that is new, one may move through it with relative ease, but at the expense of accuracy and at the expense of taking advantage of the opportunity for new learning that such circumstances provide.

This framework has applications to multiple aspects of behavior and thinking. It could even be applied to some of the central tenets within the philosophy of science, and particularly Thomas Kuhn’s assertion in *The Structure of Scientific Revolutions*, that scientific communities resist accepting new paradigms to explain phenomena that are thought to be explained adequately with existing paradigms. Existing paradigms might be considered a familiar, procedural way of doing things which, while they are economical, may function in this manner at the expense of allowing for new learning. To accept a new paradigm requires cognitive effort, and unless science can be persuaded that the new ideas are, in essence, worth the effort, there is a default to the familiar, overlearned ways of understanding.

Subcortical Structures and Cognition requires such a paradigm shift – in this case, from a predominantly cortically based way of understanding behavior and the left-right brain dichotomy and verbal-nonverbal aspects of thinking with which it is associated, to a vertically organized way of understanding behavior in which the role of deep brain structures is highlighted, in the context of their dynamic and reciprocal relationships with cortex. The book will reward those scientists and practitioners willing to expend the cognitive effort necessary to reframe their familiar ways of thinking to accommodate these ideas.

Paradigms shift when they have to do so, on the basis of overwhelming evidence that precludes the old paradigm being considered as sufficient to explain a phenomenon. “Wild science” and assertions founded in the absence of persuasive evidence do not result in paradigm changes, but paradigms must shift when the right conditions are met – when all the evidence points to the correctness of a new way of thinking to replace that which no longer provides the best fit. Perhaps the Kuhn-ian analogy is not a perfect one, because the authors have not replaced the concept of hemispheric specialization, but they have immeasurably enriched aspects of it while they highlight its limitations and provide rich information to fill these gaps. Their ideas are far from “wild science.” To the contrary, the ideas within this book are founded upon an enormous body of literature that they extensively and thoughtfully review. It is integrated elegantly within their theoretical assertions, in a manner that allows multiple aspects of thinking and behavior to be understood in ways that have not heretofore been explained in a satisfactory manner in the absence of this knowledge.

Right-left/nonverbal-verbal dichotomies and a corticocentric view made sense in the context of the information available about brains historically, which was predominately based on examining the impact of injuries to adult, fully formed brains. Since the historical limitations in imaging technology have been overcome, however, the information available about brain function has expanded exponentially. Continuing to fit our data into old ways of explaining things is no longer necessary nor is it satisfying. Just as the ability to gate the release of automatic, procedural learning in favor of higher level, cortical reasoning serves human adaptation by allowing people to take advantage of opportunities to learn about and master a broader range of demands, clinicians and practitioners who make the cognitive effort necessary to read and understand the information presented in this volume have the opportunity to gain an adaptive advantage as will the patients they serve.

How much cognitive effort is necessary to make this shift? The first several chapters can be a bit intimidating, in which the authors describe in detail the prototypical frontal-basal ganglia circuits that function interactively to subserve movement, cognition, affect, and motivation, and they explicate dynamic changes in neuroanatomy that govern tasks as they move from higher order control to being mediated more automatically. While the neuropsychologists, psychologists, psychiatrists, pediatricians, developmental pediatricians, and neurologists who stand to gain so much by reading this book have all been schooled in neuroanatomy, many may not have been exposed to the level of neuroanatomical detail that the first few chapters describe. And even for those who have been taught this material, it is not likely to be automated information that can be retrieved without a good deal of cognitive effort. The chapters are exceptionally well written, but the material is dense and those of us who ordinarily feel a sense of mastery within our field of practice might feel a bit unbalanced by how much these first three chapters may illustrate to us that we do *not* know. It may be tempting to read the chapter summaries and shelve the book as a reference. Don't make this mistake. Instead, read the first chapters to grasp the concepts that the authors are describing - which you will - and move forward. Those who may not have felt smart during the first three chapters will be rewarded by feeling *very* smart thereafter. For the book is exceptionally well written, theoretical concepts are presented in terms that are easily assimilated, and there are multiple real-world analogies incorporated to explicate ideas as well. As an extra treat, the authors introduce each chapter with passages from references as diverse as Mark Twain, Albert Einstein, Yogi Berra, Aristotle, Jonas Salk, and Oliver Wendell Holmes.

But move forward only if you are prepared that some sacred cows may have to be, if not sacrificed, then moved to a less prominent place in the barn. Among them is the value of composite index test scores that are calculated on the basis of multiple subtest scores each of which, itself, may rely on a variety of subcomponent functions and may represent the integration of a broad spectrum of functions that bear little relationship to one another. Lest we fret at having familiar frameworks for thinking disrupted, rest assured that in the place of the centrality of such scores, the authors provide a framework within which we can glean so much more information about the patients we see within the same data sets that we are accustomed to collect. They provide a means by which we can approach a consideration of quantitative and qualitative performance of the subtest scores contributing to the indices. They highlight the critical importance of understanding the nuanced differences in the demands made by subtests that purport to measure the same construct. They argue for the importance of an ipsative consideration of the relationship between the individual scores, which, if they are considered in isolation, may obscure important information. They highlight the importance of recognizing the manner in which statistics may distort information, such as by forcing behaviors that are not normally distributed

into a “bell shaped curve.” They argue that this may obscure the importance of errors that appear “normal” on the basis of these statistical machinations, but which should more rightly be considered as pathognomonic signs.

Another sacred cow who needs to move aside is a collection of familiar ideas about the functions that specific, familiar tests measure. Rather than taking a test’s “name” at face value and conceptualizing its demands according to that name, the authors posit that what defines a neuropsychologist is the ability to analyze the cognitive requirements of different tests and interpret findings based upon a solid grasp of underlying neuroanatomic functions that drive test performance, in consideration of important historical information about a patient and important qualitative observations of his or her behavior. Performance on tests that have long been assumed to measure frontal or temporal cortical processing can be impacted, potentially, by pathology anywhere within the circuitry that connects frontal and temporal regions with the subcortical structures and circuits that subserve them. The authors provide a compelling review of literature to support these views, and present fascinating data from a neuropsychological assessment of a patient with a hypothalamic tumor that was impinging upon basal forebrain circuitry. His neuropsychological tests results, interpreted blind, would lead to a sure conclusion of cortical impairment, but his frontal lobes were, in fact, entirely unimpacted. It is likely that the review of any of the various cases in this book will lead clinicians reading this book to consider, or reconsider, a variety of the conclusions they have reached for patients they have tested in the absence of having this framework with which to consider their findings.

The authors point out that as our knowledge of brain functioning expands, applying neuropsychology and neuropsychological assessment to populations beyond brain injured adults has increasingly been possible. Child neuropsychology is a dynamically evolving field that stands to gain much by being able to consider the assessment of children with an appreciation of subcortical processes. It is also the field that has been most hampered by a corticocentric view, given that cortical functions have only minimally come “on-line” for young children who are still in such a dynamic state of neurological development. Focusing on tests that measure cortical functioning for this population is akin to looking on Main Street for a dime dropped on Maple Street because the light is better there. Being able to replace a corticocentric view with an approach to testing children that highlights and explains processes taking place below the cortex – where most of the action is in this population – is of extraordinary value. The authors highlight the centrality of subcomponents of “attention,” which they argue, are perhaps better characterized as processes of “intention” insofar as they subserve the individual’s ability to form intentions and to bring these intentions to fruition. The centrality of the basal ganglia’s role in helping the individual know when to start a behavior, stop a behavior, not start a behavior, and not stop one is at the core of its role in attention/intention. The dynamic relationship of these basal ganglia functions and cerebellar processes that regulate the rate, rhythm and force of the behavior that is released, is also highlighted. The authors provide compelling, and readily assimilated, explanations of the manner in which dysfunction in these systems underlies a broad spectrum of problematic, maladaptive behaviors. They provide applications of their ideas to a consideration of multiple disorders that are often the focus of a child assessment, including attentional disorders, learning disorders and autism spectrum disorders.

The book also broadens the application of neuropsychology and neuropsychological assessment into child and adult psychiatric populations, by presenting a model of thinking and behavior that erases the illusory distinction between “psychiatric disorders” versus disorders that are more organically based. Instead, the book presents a way of understanding many psychiatric disorders

as akin to developmental disorders that are founded upon dysfunction in the subcortical systems that heretofore have been considered to play a modulatory role in motor functions. Arguing that these structures play the same modulatory role in thinking and emotional control that they play in motor control provides a framework in which multiple psychiatric symptoms can be understood. Understanding these principles allows the value of comprehensive neuropsychological assessment for a psychiatrically disordered patient who has never experienced a known neuropsychological insult to be appreciated.

Those who read this book should be willing to elaborate on the notion that language is a left-hemisphere function; should be willing to consider the cluster of behaviors that are construed as criteria for Nonverbal Learning Disorders in a manner that does not cast language in a central role; should be willing to consider the gross limitations of the Diagnostic Statistical Manual for Mental Disorders (DSM) to describe the processes captured by neuropsychological assessment, and should be prepared to construct reports in which the DSM labels at their conclusions are their least interesting and informative components.

In addition to providing extensive review of the existing literature and framing their theory accordingly, the authors provide case material from a broad variety of patients. Their examination of these data in the context of their theoretical assertions idea is nothing less than fascinating. Whereas clinicians are likely to be familiar with many of the instruments used in these evaluations, walking through these data with the authors in an interpretive role is akin to taking a museum tour with a gifted docent. Accordingly, the data may look familiar, but they can be seen in much greater detail and context with the benefit of this interpretive strategy.

Despite its straightforward, scientific title, the book is nothing less than inspiring. It is easy to imagine that many clinicians will be drawn, after reading this material, to pull old files and re-examine data from collected from patients who, with the benefit of this context of approach, could be understood so much more fully and dimensionally. If the community is lucky, these authors will go on to develop formal measures for procedural learning that will allow these concepts to be codified within the framework of standard processes for measurement. The central tenet of the book however, would seem to posit that while such formal procedures will be important and exciting, it is the responsibility of the clinician to bring higher order control to consideration of the data in every case. The more we fulfill our responsibilities to familiarize ourselves with neuroanatomy and neurocognitive constructs, and the more automatic and familiar this knowledge becomes to us, the more we will liberate our cortexes to bring higher order control and creative thinking to our field to move us to the next step.