

Has Scala Naturae Thinking Come Between Neuropsychology and Comparative Neuroscience?

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Within the broad domain of neuroscience there is a divergence between those journals that focus on human clinical topics and those that take a decidedly comparative evolutionary and nonhuman approach. This distinction reflects a deeper separation between two branches of neuroscience: the human neuropsychological and the comparative neuroscience fields. I argue that this divergence is a reflection of scala naturae thinking and that greater strides in scientific thinking can be gained by overcoming this bias in favor of deep continuity across the human and nonhuman subdomains of neuroscience.

Two Separate Disciplines

If one takes even a superficial glance at the distribution of scientific journals in the broad domain of neuroscience it would be difficult to ignore a particularly obvious divergence between those journals that focus on human clinical issues and those categorized by a comparative evolutionary approach. As just one example, The American Psychological Association's description of its prominent journal *Neuropsychology* reads as follows:

Sought are submissions of human experimental, cognitive, and behavioral research with implications for neuropsychological theory and practice. Articles that increase understanding of neuropsychological functions in both normal and disordered states and across the lifespan are encouraged. Applied, clinical research that will stimulate systematic experimental, cognitive, and behavioral investigations as well as improve the effectiveness, range, and depth of application is germane.

This is a fairly general definition that encompasses three main characteristics of *neuropsychology*. It deals with the brain and its effect on behavior. It is mainly clinical in orientation and is almost always applied within the context of understanding the effects of brain damage or pathology. Lastly, it is human targeted. When other species are employed it is almost exclusively as "models" to address questions experimentally about human brains. Therefore, neuropsychology is a heavily applied area aimed at addressing human problems. It is closely aligned with and similar to the fields of neuropsychiatry, behavioral neurology, and clinical psychology. All of these disciplines deal with the relationship between neurological conditions and psychological function, almost exclusively in humans.

Comparative neuroscience is a discipline steeped in a very different tradition than neuropsychology. Comparative neuroscience is rooted in the broad field of comparative psychology and parallel fields concerned with the biological

basis of animal behavior such as biopsychology, psychobiology, behavioral biology, and neuroethology, all of which are designated proxies for the study of comparative psychology in most universities today. In contrast to the APA's *Neuropsychology*, another premier journal focusing on the anatomy and function of the nervous system, the *Journal of Comparative Neurology*, describes itself the following way:

The Journal of Comparative Neurology appears weekly and publishes papers on the anatomy and physiology of the nervous system. Its field is broadly defined but does not include clinical neurology, neuropathology, psychiatry, and introspective psychology excepting insofar as these bear on the anatomy and physiology of the nervous system...

This journal is representative of the domain of comparative neuroscience as distinguished from neuropsychology. The emphasis is clearly on the comparative, that is, nonhuman and nonclinical nature of the research.

Although the fields of neuropsychology and comparative neuroscience focus on the study of the relationship between brain and behavior the overlap between these two disciplines, *de facto*, essentially ends there. Neuropsychology is primarily applied in its goals or, if basic, then ultimately has an applied objective. Comparative neuroscience typically involves basic research and does not implicitly regard application as the ultimate goal. The former has historically been a largely clinical field of study of humans (but now with noninvasive neuroimaging methods neuropsychology has become increasingly experimental) whereas the latter has always been experimental (unless applied in a veterinary setting, in which case it is generally considered veterinary medicine instead of comparative neuroscience). Neuropsychology typically deals with proximate causes of behavior and mechanisms of dysfunction, that is, the *how* questions about the relationship of the brain to cognition and behavior in the present. Comparative neuroscience is not always explicitly evolutionary because some paradigms do not focus upon these issues, but certainly one of the main themes of most of comparative neuroscience is the attempt to place similarities and differences across species within the context of evolutionary history and phylogeny – the *why* questions. Finally, neuropsychology is aimed primarily at understanding the human brain. Comparative neuroscience typically focuses on the study of species other than humans and, ideally, comparisons across several species (that may include humans). The dividing line between the two disciplines arguably resides mainly in the almost exclusive focus on either human brains or nonhuman brains, respectively.

Because of their different histories, orientations, and objectives, neuropsychology and comparative neuroscience are separate disciplines. I argue that this divergence is a disadvantage for both disciplines because they actually share the same domain, that is, the study of brains and their relationship to behavior. But each field has generated and relied upon a different information base because of different methodologies. Therefore, both neuropsychology and comparative neuroscience, as any two related fields of study, are at a distinct disadvantage when not sharing information and at a distinct advantage when doing so. Although it may be argued it is more efficient to organize research into these separate categories, the main point is that there should be multiple venues for, at the very least, bringing the two together at some level of discourse.

Philosophical Basis for the Separateness

It might seem that the divergence of neuropsychology and comparative neuroscience is an historical accident due to the ebb and flow of various traditions. But, I argue, the division between these two disciplines is a reflection of a much deeper philosophical bias in our view of the difference between humans and other animals. In 1969, Hodos and Campbell elegantly called attention to the problem when they targeted *scala naturae* thinking as an important factor hindering the development of comparative psychology. The *scala naturae* is an idea that is first proposed in writing in *Historia Animalium* by Aristotle (384-322 BC). The *scala naturae* (which also became synonymous with the term Great Chain of Being from the European Middle Ages), describes the view that the universe is hierarchically arranged into fixed levels of increasing perfection and “advancement.” The “ladder of progress” begins with inanimate objects on the bottom rung and moves progressively up through plants to “lower” animals (e.g., invertebrates), “higher” animals (e.g., vertebrates), humans, angels, and, in many renditions, a deity. According to this view, humans are separate from and elevated above other animals. Furthermore, humans occupy a special position on the scale as part spiritual being and part animal (Lovejoy, 1936).

Another characteristic of the *scala naturae* is its close and implicit relationship to teleological arguments. The teleological argument holds that there is a purposeful progression in cosmic and biological evolution towards better or more advanced organisms. In this view, human beings are the end goal of the evolutionary process. As Hodos and Campbell (1969, p. 399) relate:

These ideas have been succinctly expressed in the following lines by Emerson:

Striving to be man, the worm
Mounts through all the spires of form.

While this view of the animal kingdom may have a certain amount of face validity, it too runs contrary to the currently accepted data on the course of evolutionary history which indicate that primates represent only one of the many lines of vertebrates which have evolved and survive today.

Despite our advancements in scientific knowledge in the areas of evolutionary biology, zoology, and related disciplines, and, moreover, despite our protestations to the contrary, the *scala naturae* view insidiously pervades our worldview and does so both implicitly and explicitly. The language we use betrays the pervasive nature of *scala naturae* thinking. For example, the terms “ascent” (despite the fact that we are descendents – not ascendants – of our ape ancestors), “higher”, “advanced”, “highly evolved” are all popular descriptors of our own species in relation to other species. Likewise, terms such as “primitive”, “lower”, and “subhuman” are still applied in the scientific and popular literature when describing nonhuman species. These terms betray the fact that our thinking is still heavily influenced by the *scala naturae* concept. The realization that we still rely heavily on a notion about nature that dates from before 300 BC should be of considerable concern to us.

The *scala naturae* is also implicit in the way our biological disciplines are set up. Neuropsychology and comparative neuroscience are excellent examples. The divergence and separateness between these two disciplines are, in my view, a

direct consequence of *scala naturae* thinking. As a consequence of viewing humans as qualitatively different from other animals studies of humans and other animals became part of separate disciplines. Therefore, in order to bring about true intercourse between neuropsychology and comparative neuroscience we would have to shift our view radically about the nature of humans in relation to other species. This would necessitate deep acknowledgement of the continuity across humans and other species. This process does not imply that there are no discontinuities among species. In fact, one version of the continuity hypothesis can lead to the mistaken view that other species are less perfect or incomplete forms of humans. This view, in essence, is *scala naturae* thinking all over again. What I argue for is a paradigm-shift that takes the form of our deep acknowledgment of the higher-order continuity in the biological *nature* of human and nonhuman species. This view is well expressed by the philosopher Owen Flanagan (2002, p. 3) in the statement:

Humans don't possess *some* animal parts or instincts. We *are* animals. A complex and unusual animal, but at the end of the day, another animal.

What is Gained from Bringing Together Neuropsychology and Comparative Neuroscience?

There is something quite tangible to be gained by both the fields of neuropsychology and comparative neuroscience if there were more interaction between them than there currently is. In addition to widening the scope of one's knowledge to other literatures, what is gained is a perspective about the nature of the phenomena the disciplines address. Neuropsychology can be better informed by removing the human brain from its unique place within the *scala naturae* and placing it in the context of other animal brains. This can be accomplished when we realize that the human brain necessarily must conform to the same first principles that shape other brains. Higher-order continuity can be used as a framework for understanding lower-order differences among species in both basic and applied domains. One particularly illustrative example of the insights that can be gained from an integrated approach is that of the discovery of unique spindle-shaped cells in the anterior cingulate cortex of humans and great apes (Nimchinsky et al., 1999). These special neurons are severely affected by Alzheimer's disease. By using a comparative evolutionary approach to the distribution of these unique cells across the primate order the authors are able to make a significant contribution to our understanding of the phylogenetic basis of Alzheimer's disease and other human clinical syndromes. Likewise, comparative neuroscience can benefit from incorporating the extensive knowledge of the human brain that neuropsychology offers and extending that knowledge to our understanding of other primate brains in a truly comparative manner.

Fortunately, there are a number of ways in which successful efforts have been made towards uniting applied human research with basic comparative research. These efforts are apparent in the recent trends towards multi-, interdisciplinary, and integrative programs in the study of psychology, biology, zoology in many universities. Likewise, several prestigious journals, such as *Nature Neuroscience* and *Trends in Neurosciences*, reflect this broad approach. These points notwithstanding, there is a long road ahead of us if we are to exorcise

scala naturae thinking from the whole of society and reap the rewards of more highly integrated and truly comparative science.

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