Crocodile Cognition: Tracing the Roots of Cognition

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This thesis is submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

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JOHANNESBURG

May, 2019

Abstract

For millennia the reptiles have been considered inferior animals, saddled with a poor reputation, to be scorned and shunned. Similarly, the reptilian brain has been characterized as simple, in no way capable of matching the intellectual heights achieved by mammals, and more recently birds. Reptiles, including crocodiles, have been thought to exhibit behaviours solely in response to specific stimuli, unable to think, plan ahead, and consider their actions. Fortunately, our understanding of reptilian behaviour is undergoing a renaissance, due to the accommodation of their life history and physiology in the analysis of their behaviour. Reptiles have been shown to be capable of complex behaviours such as play, long term parental care, complex social structures and courtships, communication and tool use. With this evolving view of reptilian behaviour comes an evolving view of the reptilian brain. The crocodilian brain in particular, due to their phylogenetic proximity to birds, has garnered significant recent attention, but mostly due to the desire to understand how the bird brain evolved. This thesis takes the view that the crocodilian brain should be understood in its own right, prior to aligning it with either avian, or other reptilian, brains. Given this, the current thesis presents a series of studies, focused on the functional neuroanatomy of the Nile crocodile brain, with a specific focus on the telencephalon – that part of the brain known to generate complex behaviours. The studies begin with a classical architectural analysis of the telencephalon, supplemented with immunohistochemical staining methods, to provide a baseline regarding the organizational complexity of the Nile crocodile telencephalon. This is followed by a study of the catecholaminergic system throughout the crocodile brain to reveal whether this neural system, that plays a major role in the modulation of neural processing networks, evinces features homologous or analogous to those observed in mammalian and avian brains. Using state of the art magnetic resonance (MR) imaging, a three dimensional atlas of the Nile crocodile telencephalon has been produced, and this atlas played a critical

role in the subsequent functional MR imaging study that follows. Without going into exhaustive detail, the findings of the current series of studies, while providing many answers, has generated more questions than answers. What is patently clear is that the brain of the Nile crocodile, especially the telencephalon, is far more complexly organized than previously thought, exhibiting clear hierarchical neural processing networks that are central to the production of complex behaviours. This hierarchical processing demonstrates one of the most significant findings of this study, namely that birds, mammals and reptiles share a conserved system of sensory processing. At present we are only scratching the surface when it comes to our understanding of the interaction of the reptile brain with their environment and their behaviours (both overt and covert), but what the studies contained in this thesis clearly show is that with more work we will continue to unravel the complex inner workings of the reptile brain. This future work will lead us on a path that will change our preconceived and historical notions of this important and interesting class of amniote vertebrates, and allow us to regard them with the esteem they deserve.