Anatomy & Physiology: Current Research
ISSN: 2161-0940

Hoffmann, Anat Physiol 2014, 4:2
DOI: 10.4172/2161-0940.1000e132

Editorial Open Access

Assembly of the Human Mind: How Present Day Primates Reflect our Mind's Anatomical and Physiological Evolution

Michael Hoffmann*

Professor of Neurology (UCF), Director Cognitive Neurology and Stroke Programs, JAH-VA Hospital 13000 Bruce Down's Blvd, USA

Biological, gene based evolution is readily and often dramatically demonstrated in animals. In our instance, primate biology and anatomy is notable for the similarities to us including with the chimpanzee brain closely resembling our own. In addition, with over 98% commonality in genes, between humans and chimpanzees, the obvious question is how did our minds become so different? Evolution in humans has taken on a different dimension with cultural, meme (ideas, behaviors) based evolution, having taken over from biological evolution in the last 50 thousand years. This applies particularly to the mind, with a timescale dramatically different, measured in minutes to years rather than tens of thousands to millions of years.

It might be presumed that anatomy and physiology have a lesser part to play with the development of the mind. How do we understand and regard the anatomy of the mind? A different perspective is required. Our bodies and brains reveal vestiges of the past but a major challenge has been the ephemeral mind, the development of which purportedly has no vestigial traces because it has no fossil correlate. Perhaps we have had blinkers on and not looked in the right places. Even casual scrutiny of our living primate relatives can be very illuminating of the hoops and loops our brain took to where it is today. We can see the different component intelligences such as visuomotor skills, language and executive function represented in different primates that still exemplify one or more of this attributes today. Some examples;

Sensory Motor Integration – Overall Increase in Hierarchical Integration Represented by Monkeys and Lemurs Today

Purgatorius, the ancestral monkey, was the first to become arboreal, in an environment that placed a premium on stereoscopic vision, accurate hand-eye coordination to catch that next branch at dizzying heights. These circuits laid the beginnings of the extensive frontoparietal connections that underlie the all-important human attributes of high level working memory, recursive language, executive function and episodic memory.

Dorsal and Ventral Stream Visual Pathways (Monkeys and Lemurs)

Almost half of the human brain has to do with vision processing. During the arboreal niche occupation, many millions of years ago (mya), primates further developed the ventral visual stream for object and face identification and the dorsal visual stream for motion detection and visuospatial function. In humans with a stroke for example or due eclampsia these are pathways that are rendered impaired, causing piecemeal vision (simultanagnosia) or face recognition problems (prosopagnosia) and inability to recognize everyday items (object agnosia). Macaque monkeys, Lemurs' abilities are representative of this stage of our evolution today.

Lemurs, Trichomatic (Good Color) Vision and the Snake Detection Theory

Here lemurs are particularly noteworthy, having never been exposed to venomous snakes, they remained with relatively low-level vision. African primates and humans have much better trichomatic vision. This has been attributed primarily to the evolutionary value of venomous snake detection, typically patterned and colorful. South American primates with much less exposure to venomous snakes have intermediate color vision [1].

Musical Protolanguage - Gibbons, the Singing Apes

Gibbons are monogamous and sing duets together to strengthen their pair-bond, also are noted for their prolonged altriciality (relatively undeveloped requiring extensive nursing). They are considered to have split from our last common ancestor about 18 mya. Their musical language provides a basis for the presumed human musical protolanguage that is a strongly favored theory of our language origins, in particular the holistic manipulative, musical, multimodal (Hmmmm) theory of Mithen [2].

Early Language and Communication – Vervet Monkeys

Vervet monkey have unique and specific alarm calls for snakes, eagles and leopards. Chimpanzees have often been trained in the hopes of acquiring human language without success in the last 100 years. However captive South Florida chimpanzees became famous recently, when a small, threatened group stole a boat and set up on a new island. Their communication and language was studied by Andrew Halloran with the aid of a spectrogram he subsequently identified over 25 different chimpanzee phrases [3]. Chimpanzees have a language of their own which is sufficiently complex to undertake such a project.

Sleep Stages and the Tree to Ground Transition – The Unwieldy Gelada Baboon Solution

Gelada baboons sleep on side of cliff for protection, underscoring the tremendous vulnerability mammals and primates have during sleep. Our present day, complex, 5 stage sleep cycles reflect the tradeoff between restorative sleep and intermittent light sleep (stage 2, about 50% of our sleep time) that facilitates possible predator awareness. Sociality and the discovery of fire allowed tree to ground transitioning with improved stage 4 and REM sleep, both of which enhance creativity [4].

***Corresponding author:** Michael Hoffmann, Professor of Neurology (UCF), Director Cognitive Neurology and Stroke Programs, JAH-VA Hospital 13000 Bruce Down's Blvd, Tampa, Fl, 33612, USA, Tel: 813-9722000 ext 7633; E-mail: mhoffmann4@me.com

Received February 05, 2014; **Accepted** February 06, 2014; **Published** February 08, 2014

Citation: Hoffmann M (2014) Assembly of the Human Mind: How Present Day Primates Reflect our Mind's Anatomical and Physiological Evolution. Anat Physiol 4: e132. doi:10.4172/2161-0940.1000e132

Early Brain Foods. The Spider Monkeys and Howler Monkeys

During one of the warmest times on Earth, about 50 million years ago, forests became widespread and fruit eating (frugivory) became a niche option that early primates exploited. As a high level nutritious food, it may have facilitated brain growth. In South American forests today, both Spider monkey and Howler monkeys reside, are of similar in size but the former eats almost exclusively fruit while the latter ingests very little. Spider monkeys have brains that are about twice the volume of Howler monkeys. A good case for our assertion that frugivory is a cornerstone of brain foods?

Tool Making and Working Memory - Chimpanzees

Chimpanzees our closest animal relative, are considered to have a grade 2 working memory capacity (rarely 3, on a scale of 1-7), on the basis of multiple convergent studies. We are graded with a capacity of 7 [5]. Basic stone tool making ability correlates with this capacity. They are living examples of where we started 3-4 million years ago and subsequently moved on to attain greater brain volume and intra-connectivity allowing us to achieve our current complex brains.

Theory of Mind, Executive Function and Language Evolution

Sociality is aptly demonstrated by the extensive grooming amongst baboons as well as apes. From this we surmise that the circuitry for theory of mind developed over the subsequent millions of years. Michael Arbib has proposed an increasingly complex 7-stage model that subsequently allowed us to achieve modern language, building on this brain circuit that evolved in the social groups [6].

The core of all executive function is considered to be working memory capacity. This represents the intra-connectivity of our brains between the key intelligence domains of natural history knowledge, tool-making, language and social intelligence. What neuroanatomical evidence do we for this? The neuropil is decreased in Broca's area 10 (BA 10) also called the frontopolar cortex in humans relative to other primates and is twice as large in terms of overall brain volume compared to any of the other great apes (1.2% in humans versus 0.46-0.74% in great apes). Interestingly, BA 13 is relatively reduced in humans. Spindle cells or Von Economo cells appear in both the fronto-insular cortex as well as the anterior cingulate cortex, only in humans and African great apes and are approximately 30% more numerous in the right hemisphere of these species [7]. These probably sub-serve the role of social and emotional processing which arose many millions of years before language [8]. As an example of convergent evolution, other intelligent species such as the cetaceans also have spindle cells [9]. The increase in neuropil, particularly of BA 10 is likely related to the connectivity of this region with other tertiary association cortex and the other hemisphere [10]. Such micro-anatomical differences can be discerned but at the phenotypical level are revealed but he differences between our cultural, language and tool making capabilities between us and our nearest primate relatives.

Our brain has been dubbed the most complex thing in the universe. Even though magnanimous efforts such as the human brain project spearheaded by neuroscience is underway, we need all the help we can get. Charles Darwin and Jane Good all have shown us that astute observation (without human intervention) of that which is natural may sometimes lead to some of the greatest advancements in science.

References

1. Isbell LA (2009) The fruit the tree and the serpent. Harvard University Press, Cambridge Massachusetts, USA.
2. Halloran A (2010) The Song of the Ape. St Martin's Press, New York.
3. Mithen S (1996) The prehistory of the mind. Thames and Hudson, London.
4. Anderson JR (1998) Sleep, sleeping sites, and sleep-related activities: awakening to their significance. Am J Primatol 46: 63-75.
5. Renfrew C (2009) Situating the creative explosion: universal or local? In: Renfrew C, Morely I (Eds). Becoming Human. Innovation in Prehistoric Material and Spiritual Culture. Cambridge University Press, Cambridge.
6. Rizzolatti G, Arbib MA (1998) Language within our grasp. Trends Neurosci 21: 188-194.
7. Semendeferi K, Armstrong E, Schleicher A, Zilles K, Van Hoesen GW (1998) Limbic frontal cortex in hominoids: a comparative study of area 13. Am J Phys Anthropol 106: 129-155.
8. Hof PR1, Mufson EJ, Morrison JH (1995) Human orbitofrontal cortex: cytoarchitecture and quantitative immunohistochemical parcellation. J Comp Neurol 359: 48-68.
9. Hof PR, Van der Gucht E (2007) Structure of the cerebral cortex of the humpback whale, Megapteranovaeangliae (Cetacea, Mysticeti, Balaenopteridae). Anat Rec (Hoboken) 290: 1-31.
10. Semendeferi K, Armstrong E, Schleicher A, Zilles K, Van Hoesen GW (2001) Prefrontal cortex in humans and apes: a comparative study of area 10. Am J Phys Anthropol 114: 224-241.