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A *g* beyond *Homo sapiens*? Some hints and suggestions

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Abstract

This article proposes that a complete account of cognitive evolution may have to accommodate a domain-general source of variance in mental abilities accounting for differences among primate taxa. Deaner, van Schaik, and Johnson [Deaner, R.O., van Schaik, C.P. and Johnson, V.E. (2006). Do some taxa have better domain-general cognition than others? A meta-analysis. *Evolutionary Psychology*, *4*, 149–196.], in a meta-analysis of experiments testing the performance of different primate genera on various cognitive tasks, found a good fit to a model where the different genera differ along a single dimension of domain-general mental ability. Moreover, the examination of the literature undertaken in this article shows that the rank of a genus on this dimension predicts its brain size, recency of common ancestry with man, and life history strategy. The molecular evolution within the primate order of genes implicated in brain size coincides with this pattern and thus provides some support for the phylogenetic inference that there has been directional selection for general cognitive ability in the lineage leading to *Homo sapiens*. Taken as a whole, these data suggest a generality of *g* (or something like it) even wider than has been supposed.

Keywords: *g*; Primate intelligence; Brain size; Life history; *MCPH1*; *ASPM*

1. Introduction

Our impression of affinity with the great apes arises from more than physical resemblance. Watching one pygmy chimp imitate the headstands and tumbling of another, most of us would probably be unable to shake off the intuition that they also share our intelligence to a profound degree. But what exactly is the nature of this cognitive affinity? Conversely, how can we characterize the vast remaining difference?

A prominent strand of thought in current evolutionary psychology would answer that the human mind owes its powers to a series of modules that have each been independently optimized for some narrow domain (Tooby & Cosmides, 2005). On this view natural selection has been installing and refining one such mental module after another in response to various well-defined adaptive problems faced by our ancestors. The accumulation of these modules during the six million years since the separation of the human and chimpanzee lineages is supposed to account for the cognitive capacities that appear to distinguish man in such a distinct qualitative manner from even his closest relations in the primate order.

Differential psychologists may note that a datum of nontrivial significance to their field appears to be absent from the picture that emerges from the mainstream practice of evolutionary psychology. What about the positive manifold? In other words, if human cognitive abilities can be broken down into modules of independent origin and functionality, why is it that a diverse battery of mental tests administered to a large and

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representative sample of a human population always shows a covariance matrix with all-positive entries? It might seem that any complete account of cognitive evolution must account not only for taxon- and domain-specific modules but also the g factor. Indeed, Jensen (1998) has thought it obvious that a biologically rooted variable of such prominence as g must be "necessarily a product of the evolutionary process" (p. xii). Rushton (2004) has gone further and suggested that g is a construct capturing differences in mental abilities among taxa as well as within the particular taxon (ours) to which it is typically applied. The roots of this notion can be traced at least as far back as Jerison (1973), who noted the prominent trend toward increasing brain size in the fossil record and proposed a concomitant increase in a capacity for flexibly adaptive behavior.

Some recent results from disciplines outside of differential psychology are presented here that together form a cohesive picture with longstanding results from within it. This picture suggests that evolutionary perspectives on mental abilities should be expanded to accommodate the proposals of Jensen and Rushton. Specifically, on the basis of accumulated data regarding the comparative performance of primate genera on various cognitive tasks and a phylogenetically coincident pattern of adaptive evolution in candidate brain genes, it is proposed that in the primate lineage leading to *Homo sapiens* there has been a trend toward higher standing on a dimension of domain-general mental ability uniting disparate primate taxa and accounting for differences both within and among them. This dimension may very well be profitably thought of as g itself. Much of the proposal is quite tentative, but its statement is deemed useful nevertheless as a potential spur to further thinking and research. Promising directions for further inquiry are sketched herein.

2. Methods and results

2.1. The meta-analysis of Deaner, van Schaik, and Johnson (2006)

This article discusses the results of a creative review by the evolutionary psychologist Robert Deaner, the primatologist Carel van Schaik, and the statistician Valen Johnson. In their original paper Johnson, Deaner, and van Schaik (2002) compiled thirty reports comparing the mental abilities of different primate genera and devised a novel methodology for their meta-analysis. The meta-analysis included assessments of twenty-four primate genera in their performance on nine different cognitive tasks: (1) *detour*, (2) *patterned string*, (3) *invisible displacement*, (4) *tool use*, (5) *object discrimination learning set*, (6) *reversal learning*, (7) *oddity*, (8) *sorting*, and (9) *delayed response*. Deaner et al. (2006) provide a much more detailed explication of these paradigms, their associated methodological subtleties, and the decision rules governing the inclusion and scoring of the studies in the meta-analysis. Many of these paradigms are also summarized and illustrated with helpful figures in Jensen (1980a, pp. 175–182).

The raw data collected by Deaner et al. (2006) are performance rank orders of three or more primate genera within experiments employing one of the above-named paradigms. This description may suggest a factor-analytic approach toward the natural question as to whether performance across the several cognitive tasks is dominated by a single dimension. However, because the collected studies suffer from awkward features such as tied ranks and missing data that frustrate traditional multivariate analyses, a complex amalgam of Bayesian and Markov Chain Monte Carlo techniques was devised to circumvent these difficulties. A full explication of the model lies beyond the scope of this article. As the summary below is primarily conceptual in nature, the interested reader is advised to consult Johnson et al.'s (2002) original paper for a full-dress mathematical exposition.

Essentially, it is assumed that the performance ranks of primate genera within a given experiment are determined by three sources of variance: (1) a dimension of *domain-general mental ability* affecting all paradigms; (2) *paradigm–genus specificities*, that is, random effects accounting for the possibility that a genus systematically performs better on some paradigms than on others in a way that the domain-general ability cannot explain; and (3) measurement error specific to the experiment conducted within the paradigm. We thus have a latent ability z_{ij} satisfying

$$z_{ij} = g_i + s_{i,l(j)} + e_{ij},$$

where z_{ij} denotes a latent variable representing the perceived performance of the ith genus in the jth study. $l(j)$ denotes the paradigm to which the jth study belongs. The variable z_{ij} is related to the observed performance rank of the ith genus in the jth study by making the assumption that y_{ij} (the rank of the ith genus in the jth study) is greater than y_{kj} (the rank of the kth genus in the same study), if and only if $z_{ij} > z_{kj}$. The variable g_i denotes the standing of the ith genus on the general ability factor. Paradigm–genus specificities are denoted by $s_{i,l(j)}$ and represent deviation attributable to the interaction of the ith genus with the lth paradigm.