Toward Evolving Intelligence Without Ideology[1,2]

Leigh M. Van Valen
Department of Ecology and Evolution
University of Chicago
915 E. 57 St.
Chicago, Ill. 60637, USA

Received 20 May 1989

People who care about others, or about classes of others, often go out of their way to deny any relationship between brain size and the capacity for mental function, i.e. the capacity for processing neurally encoded information. Proponents of master classes and master miniraces and the master sex have done so much gross misrepresentation in the opposite direction that it may seem that they must be entirely wrong. Ideologies are insidious things, though. Communism is the opposite of fascism in one way and its twin in another. In reacting to inhumane excesses we must take special care to keep simplified propaganda, and the reaction itself, from hiding real complexity from us under a palimpsest of plausible simplicity. (Yes, the reverse is possible too.)

There is what seems to me a very strong and general argument that brain size, suitably scaled, is rather closely related to the capacity for mental function. Before giving it, though, I note that opponents of this conclusion (I think the argument itself is new, at least in this form, so it has no critics yet) assume that there really is no relationship unless one is able to demonstrate one under strict criteria. They fail to see that absence of knowledge isn't knowledge of absence. This is the fallacy of null hypotheses (Van Valen, 1985), reifying pseudoknowledge out of a particular (Neyman-Pearson) statistical methodology, a methodology to which there are more constructive alternatives.

I don't think it is controversial that much the most important function of a brain is mental function, as defined above. Even much, if not all, of a brain's neuroendocrine activity is a result (and some is an aspect) of mental function. But brains are expensive things. It takes quite a disproportionate amount of an animal's assimilated free energy to keep the neurons of its brain active and in good repair (about 20 percent of resting metabolic energy in an adult human, where the brain's mass is 2 percent of total mass, and half or more of resting metabolic energy in young children: Hofman, 1983). The enormous size of our own brains comes with an additional cost in parturition. Brains vary in size within populations, as almost everything else does, and we know that almost all variation has a genetic component. Therefore brains would decrease in size if permitted to do so both functionally and by internal constraints. In this book Kruska reviews the considerable evidence that brains have in fact decreased in size in most domestic animals, where there is a relaxation of selection for mental acuity or even artificial selection indirectly against it. The decrease is usually 10-30 percent and affects all structural components but apparently not memory; it is a real loss and is not reversed in 1000 or more generations of feral life. The maintenance of

* * * *

[1] **Intelligence and Evolutionary Biology.** Edited by **Harry J. Jerison and Irene Jerison.** 1988. Berlin and New York: Springer-Verlag. xii + 481 pp. ISBN 0-387-16085-X. Hardbound. $120.00.

[2] Contribution 95, Lothlorien Laboratory of Evolutionary Biology

Evolutionary Theory 9: 71-74 (July, 1989)

brain size therefore requires an upward selective vector, a biological function. Like other biological traits brain size is a quasi-equilibrial resultant of both costs and benefits, and the large size of the costs here requires correspondingly large benefits. The distribution of brain sizes in any group close to selective equilibrium should therefore be rather near, but below, the distribution of values which would give the best mental function. Quantum electrodynamics (Q.E.D.)

The application of the preceding argument to variation of brain size within a species, e.g. our own (or those of our domestic animals), is direct but requires elaboration. Natural selection is a powerful force. Even a rather weak intraspecific relationship (technically, genetic correlation) between brain size and capacity for mental function would suffice for maintenance of a brain-size distribution not far from optimal. (I don't want to discuss here the relationships between measured intelligence and number of children in Western human societies, where it has been studied. This is an interesting and somewhat complicated problem, but it leads too far away.) An environment containing adequate food and good medical care weakens natural selection on brain size as it does on many other traits, but such an environment is far from universal even within our species. A positive intraspecific relationship between mental function and brain size is nevertheless to be expected; I can't think of any realistic exceptional theoretical cases, although they may exist.

So. Does intelligence (capacity for mental function, as defined above) in fact have a positive relationship with brain size in our species? We immediately run into serious problems of measurement. Those related to intelligence have been widely enough discussed that I don't think I need to repeat them. Brain size itself, though, is remarkably awkward. Take the brain from a cadaver and measure it? Well, we need to have a measure of mental function from the same individual, preferably when it was alive. Brain size decreases with age in a way that isn't adequately untangled from specific pathologies. Measure brain size in a living person? How? Radiography can do it now (tomography), but one doesn't subject the heads of a random sample of people to a good dose of X-rays. What has been done is to measure head size, even this usually not very well, and use this as a vicar for brain size. The relationship between head size and brain size in normally functioning people is inadequately studied but some bounds are possible. I reviewed existing studies in 1974, with attention to problems and controls (and a new statistical method), and concluded that there is probably a small positive relationship between brain size and measured intelligence in our species. (The conclusions of this review have been misstated in both directions by people who seem to want to prove their preconceptions more than to investigate reality.) In the present volume Hodos, who is not among that heterogeneous set, mentions one of the two more recent studies I know; the other (Susanne, 1979) estimates a somewhat stronger relationship. Height also has a low but positive correlation with measured intelligence, a relationship which is usually removed by partial correlation. However, it is unclear how appropriate it is to do so; the most likely direct causal relationship is the one affected, between head size and intelligence, but reasonable indirect causal relationships exist between stature and intelligence. Partial correlation has a greater effect on one or the other of these correlations in different studies.

Hodos reasonably advocates, as have others, that attention be paid to the relations between specific intellectual abilities and specific parts of the brain. Such attention need not be at the expense of attention to a general component, the existence of which to me is proved by the well-known prevalence of positive correlations among specific intellectual abilities. I can conceive of no more basic meaning for a general component (except perhaps the ability mentioned in the first sentence of this review), because correlation seems to require causal overlap here, nor have I found one in what psychological literature I have seen. The

existence of such a general component says nothing in itself, of course, about causes of the component. Deary reviews aspects of the subject well in the book.

Deacon, in the book, provides what is astonishingly almost the first competent analysis of human brain allometry, using principles well established in other contexts. He shows that our brain is enlarged as a whole in relation to body size, but that its cortical components have enlarged much more than the rest, especially the medulla oblongata, which interfaces with the spinal cord. Most of this pattern (and Deacon gives it in more anatomical detail; the prefrontal lobes have ostensibly the greatest deviation) can be developmentally explained in a simple way. As he notes, an increase in the time alloted to migration of later-produced neurons through the zone of earlier-produced ones gives this result. Competition among axons, decided largely by their activity, provides regional and smaller resolution and is itself partly determined by the amount of earlier migration allowed. He notes evidence that people with greater difficulty in language use have a greater part of the prefrontal lobe devoted to language. In a separate paper he reports some fascinating neuroanatomical work of his which suggests that the language-processing paths in the human brain are largely derived from similar paths in other primates which they use for vocalization.

Neanderthals are supposed to have averaged somewhat bigger brains than ours (it doesn't seem to be from sampling error, although it may well be a result of their more massive bodies but nevertheless possibly indicating greater intelligence), but it didn't save them from us. Group fitness integrates everything, and there are occasional examples of other extinct groups with apparently better single features than the survivors, as has long been known. It's something to look for. So, in a different way, is the current direction of evolution of intelligence and its aspects in our species and its social groups. We are still subject to strong natural selection, even on intelligence.

Back to intelligence. In the volume Jerison defines it as "the way an animal knows its external world" (p. 7). That won't work, both by omission and by inclusion; other definitions in the volume are worse and I will ignore them. Presumably Jerison doesn't require consciousness for intelligence, so response is one criterion for knowledge. Responses can be made by any living cell in contact with the individual's environment; I hope that, say, osmotic swelling of an exterior cell in contact with fresh water, or even an active response by the cell to reduce such swelling, isn't taken as intelligence. Conversely, much of our own intelligence is introspective. The definition in the first sentence of this review lacks these faults, whatever (besides no explicit definiendum there) it may have of its own. "Capacity for processing neurally encoded information" is meant to encompass both effectiveness and quantity of processing and, assuming that these aspects are integrated in a suitable way, is obviously a variable which is (quasi)continuous upward from 0. Measurement will present difficulties which may perhaps best be approached by using approximate criteria, as is commonly done now anyway. The definition may seem to define away the possibility of artificial or other non-neuron-based intelligence (like the Black Cloud in Fred Hoyle's provocative novel of that name), but that is easily remedied by considering functional analogs of neurons. That we can conceive of the possibility that there may be intelligence with a radically different formal basis, though, means that the definition isn't a really fundamental one. Nevertheless, it may possibly be adequate for our world.

The book deals with other topics too, such as comparative learning and even paleontology, but there isn't much new there. As internally integrated reviews they are useful. A philosopher, Michael Ruse, though, jumps into muddy and shark-infested water that should have had a more careful scanning first. He actually advocates the view that quasi-universals of culture, including and especially (he thinks) basic ethics, are based in brain structure. He may like to look at Ruth

Benedict's classic ethnographic depiction of the Dobu, or Colin Turnbull's of the Ik. (The latter, as it later turned out [Knight, 1976; Beattie, 1977], have behavior characteristic of chronically semistarved people anywhere.) Or even Sunday vs. weekday ethics of our own society. It may conceivably be that brain structure defines a norm of reaction such that particular ethical views tend to appear under different circumstances (altruism is best with a full belly?). However, the variation and the convergent similarities I know are more simply explainable by group, kin, and individual benefits, and by the social conflicts among these levels. Brain structure would then give us our humanity in an indirect way. Thus my own bias shows, and I can't offer ways to resolve the matter. If Chomsky's deep-structure universal grammar approximates reality, though (as Ruse and Lieberman say in the book), it would seem to require a basis in brain organization if not Chomsky's unimaginative saltational origin. Another novel, C.J. Cherryh's Hunter of Worlds, deals in a philosophically sophisticated and imaginative, if evolutionarily naive, way with three species which have quite different ethical frameworks because of their biological structure. Now think. What conceivable facts could falsify your own ideology?

I conclude with an interpretation of the emergence of our level of intelligence, based mostly on Deacon's papers but in part diverging from his views. Expansion of cortical and especially prefrontal size above the level of earlier allometry began in Australopithecus (Maiorana, 1989) and provided the basis for increased general intelligence. The increase of the relevant part of the prefrontals provided the capacity to form language from vocalization; the otherwise inadaptive rise of our larynx, so that the paths of air and food cross, followed some time later. Other specific brain-behavior effects are also likely, and it may be impossible now to specify just what the nature of the initial selective advantage here was.

Literature cited

Beatty, J.H.M. 1977. More on famine and the Ik. Current Anthropology, 18: 558.

Benedict, R. 1934. Patterns of Culture. Boston: Houghton-Mifflin. 272 pp.

Hofman, M.A. 1983. Energy metabolism, brain size and longevity in mammals. Quarterly Review of Biology, 58: 495-512.

Knight, J.A. 1976. On the Ik and anthropology: a further note. Current Anthropology, 17: 777.

Maiorana, V.C. 1989. A selfish theory of human origins. Evolutionary Theory, 9 (this issue).

Susanne, C. 1979. On the relationship between psychometric and anthropometric traits. American Journal of Physical Anthropology, 51: 421-424.

Turnbull, C. 1972. The Mountain People. New York: Simon and Schuster. 309 pp.

Van Valen, L.M. 1974. Brain size and intelligence in man. American Journal of Physical Anthropology, 40: 417-423.

-----. 1985. Null hypotheses and prediction. Nature, 314: 230.