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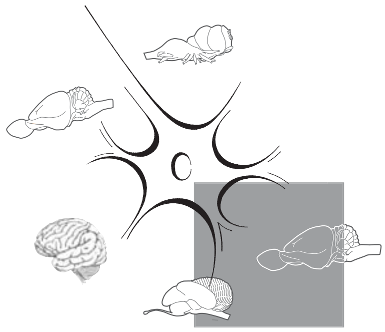

Neuroscientist's Embarrassment: Artificial Intelligence's Opportunity

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I recently met with a representative of the IBM 'SyNAPSE' group, an undertaking of the US Defense Advanced Research Projects Agency, which is aiming to build a cat brain – that is, to build an artificial brain that is broadly cat-like in its physical size, number of neurons and synapes, anatomical structure, and perhaps even its behavioral complexity. There are so many astounding difficulties in such an endeavor that good etiquette didn't allow me to point them all out, and at any rate, my impression from the meeting was that many of the members of the project appreciate what they're up against, and have realistic – and low – expectations.

But there is one wrench I did pose to the IBM representative, a 'positive' wrench. Perhaps they have *overestimated* the difficulty of building a brain with cat-level behavioral complexity in one critical respect. To begin to understand why this might be, a place to start is the excellent recent review in *Neuron* by Lars Chittka and Jeremy Niven, titled 'Are Bigger Brains Better?' [Chittka and Niven, 2009]. They cover a wealth of neurobiological knowledge from roundworms to mammals, and the short answer to the question of their title is … no, not much. The strongest driver of brain size is body size, not the behavioral complexity of the animal. Although there is some controversy (e.g. among primates [Deaner et al., 2007]), the best correlations with proxies for an animal's intelligence tend to be measures of relative brain size, or brain size corrected for body size. For example, I collected ethograms from the mid-twentieth century ethology literature, and across mammals the number of behaviors in the repertoire strongly correlates with relative brain size (EQ), not with absolute brain size [Changizi 2003, 2007].

As Chittka and Niven suggest, bigger brains may possess 'more of the same' of what is found in small brains, and the qualitative enhancements that make some brains 'smarter' probably require the evolution of specialized circuits. But we really don't know. The big embarrassment of neurobiology is that we're frankly unsure why brain size increases so considerably with body size. Greater surface area of skin and muscle would suggest that somatomotor areas should disproportionately enlarge with body size, but the primary somatosensory area and primary motor area vary in size as expected for a 'typical' area [Changizi and Shimojo, 2005].

Although embarrassingly big brains are a thorn in the side to us neuroscientists, while chatting with the IBM representative it struck me that this phenomenon amounts to a fantastic opportunity for artificial intelligence. Implicit in the background assumptions of the SyNAPSE group is that they are aiming to physically construct a cat-sized brain, having already tried their hands at smaller mouse and rat brains. But why aim for a cat-sized brain? Cat-sized brains are for cat-sized bodies, and these artificial intelligence folk aren't building bodies at all. Rather than aiming to build larger and larger brains, and thereby having to confront the severe scaling challenges in building a bigger brain [Changizi, 2007], to build a smarter brain one can, in principle, *reduce the size of the body.* That is, greater behavioral complexity tends to correlate with greater brain-to-body ratio, and so we should be able to increase behavioral complexity by enlarging the numerator, but also via shrinking the denominator. If we can ever resolve the big-brain conundrum, artificial intelligence folk may be able to give their artificial mouse brain a tinier-than-mouse body – or no body at all – and nevertheless seek out cat-level intelligence.

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