Universals in the Evolution of Intelligence. Daniel W. McShea, Biology Department, Duke University, Box 90338, Durham, NC 27708; dmcshea@duke.edu

Overall Goals and Objectives:

When we someday meet them, what will they be like? When we discover and engage with intelligent extraterrestrial life, what sort of being should we expect them to be? I intend this not as an exercise in free speculation. That ground has been covered by science fiction. Rather, I intend this as an investigation of constraints. What *must* intelligent life be like? The focus here is partly on the anatomical and physiological and partly on the psychological. Psychologically, and especially emotionally, what sort of creature should we expect to be dealing with? The proposed investigation has both empirical and philosophical components.

Empirical Component: the Correlates of Intelligence

The empirical component is a search for the necessary or near-necessary correlates of intelligence. Candidates include problem-solving, self-recognition, language complexity, degree of connectedness among individuals, group size, presence of a centralized nervous system, degree of division of labor among individuals in a group, and many more. However, there is at present no generally agreed upon understanding of intelligence itself, and therefore the most straightforward way to search for a correlation – looking for variables that are systematically high (e.g. group size) when intelligence is high and low when intelligence is low – will not work. One of the variables here, intelligence, is not measurable.

What we can do, however, is look for ensembles or packages of variables that are associated with each other, variables that *can* be operationalized and that intuitively seem connected to intelligence in some sense. Imagine a list of arbitrarily chosen taxa, each one evaluated on some appropriate scale for its problem-solving ability, self-recognition capability, and so on, with evaluations based on data available in the current literature. Imagine these data entered into a large spreadsheet. Probably most of the cells in the spreadsheet would be blank. For example, the communication complexity of the zooids in a Portuguese man o'war and the ability of snails to recognize themselves are probably not known. But the spreadsheet would be large, including any taxa for which any data at all are available, so that however sparse the entries, we would nevertheless be able to find clusters of co-occurring variables. Perhaps there is a cluster of taxa characterized by high levels of self-recognition, high division of labor, and significant problem-solving ability. And from this co-occurrence cluster we might infer that these are essential ingredients of intelligence. More precisely, co-occurrence clusters are hypotheses, candidates for features that characterize – and are necessary for – intelligence.

Importantly, the list of taxa evaluated would not be limited to those thought to represent high intelligence. It would include those with low scores on the various variables as well (e.g., poor problem-solving ability, low self-recognition capability, etc.). In the search for relationships among these variables, it will be useful to examine the full spectrum of capabilities.

Some of the clusters discovered will doubtless be the obvious ones. Language complexity will doubtless correlate with problem-solving and self-recognition, for example. But there may also be some surprises. In an unrelated project some years ago, I – along with a postdoc and others in my lab – adopted a similar strategy to investigate the major transitions in evolution, the origins of new and higher levels of association in organisms. These include the origins of higher-level multicellular individuals from association of lower-level cells, and of higher-level colonies from lower-level multicelled individuals. We collected data for a large set of taxa on variables thought to be associated with major transitions, such as division of labor, body size, reproductive skew, degree of connectedness among lower-level

entities, and so on. And then we looked for clusters of associated variables. In addition to some associations predicted ahead of time (e.g., division of labor associated with large body size), we found some wholly unexpected correlations [2]. The most surprising was the association between degree of division of labor and an intermediate level of connectedness among lower-level entities. In particular, the most advanced of the transitions to sociality were not those in which lower-level individuals were well connected with each other, or those in which they were poorly connected, but those with intermediate connectedness, in which lower-level entities retained some degree of separation and autonomy.

I explain all this to show the great potential of this approach to reveal novel correlations. It is science in its exploratory mode. Indeed it is a somewhat extreme kind of exploratory science. It relies very little on a priori theorizing, more on opportunistic collection of data, and the careful mining of a large dataset, looking for novel connections. In the study of organismal intelligence, it could – I think – open a new door to discovery.

Philosophical Component: Kant versus Hume

In the discussion of intelligence on other worlds, there is a debate that we are not having but need to have. There is a long-standing notion – which I will here call the Kantian view – that intelligence is roughly synonymous with rationality. More precisely, this view argues, intelligence in any species is a function of certain reason-based skills: calculation, logic, problem solving, learning, and pattern recognition, among others. Intelligence, in this view, is universal. It is a set of cognitive skills that can be expected to function in more or less the same way in all intelligent species, even if they are not implemented in wetware the same way.

This may seem uncontroversial, but there is another view – the Humean view – which draws attention to the fact that intelligence must be motivated, and notes that rationality alone motivates nothing. In the absence of what Hume called the passions, no deliberate behavior takes place. Importantly, Hume's passions included not just the emotions (i.e., the strong passions) but also the softer motivations, that is, the wants, preferences, cares, etc. (i.e. what he called the "calm passions"). To see the importance of the passions in Hume's sense, consider what happens in their absence. The answer is nothing at all. A perfectly rational being, devoid of passion, does nothing. It does not even get up in the morning, much less go about its day, because – lacking passion in Hume's sense – its intelligence is unmotivated. According to Hume and contrary to Kant, intelligence requires not just reason but passion, motivation.

If the Kantian view is right, then the structure of intelligence should be more or less universal. And we can prepare for our future encounters with intelligent life through the study of intelligence here on Earth. In the Kantian view, intelligence is intelligence, wherever it arises.

If the Humean view is right, then there are two possibilities. First, it could be that intelligent species everywhere will share roughly the same motivational structure – the same profile of wants, preferences, cares, etc. – and again we can prepare for future encounters by studying Earthly intelligence. One might expect this to be the case if one thinks that all or most origins of intelligence are driven by a similar set of selection pressures. It could be, for example, that intelligence requires altricial young, extended child care, non-genetic inheritance mechanisms, high levels of kin selection and altruism, and so on, and that therefore all or most intelligent species will be selected to have similar passions related to sex, child-rearing, family structure, etc.

Alternatively, again if the Humean view is right, one could argue that despite some motivational overlap, there are going to be significant differences among intelligent species. For example, the passion to survive may have exceptions in an intelligent species that has a life history like black widow spiders. A preference for fairness in a honeybee-like species may be

differentially weighted toward sisters and against brothers. A preference for avoiding embarrassment would likely be absent in any asocial intelligent species. It is questionable whether octopuses embarrass. Tigers certainly don't. The argument here is that every species with advanced intellectual capacities is going to have a unique adaptive history guiding the evolution of its motivations (not to mention the divergences arising by chance). And therefore, a reasonable first guess would be that every intelligent species is going to have a motivational profile that is unique in some important respects.

In sum, in the Humean view, we need to take seriously the study of the motivational organization of intelligent life generally, and think about which aspects of it we can expect to be universal and which to be species-specific and historically contingent [1].

In sum, the philosophical investigation I am proposing would focus on three questions:

1. Kant versus Hume: how rational is intelligence?

2. Which aspects of the motivational profile of intelligent species are expected to be universal and which historically contingent?

3. What are the implications of our answers to 1 and 2 for our estimate of the diversity of extraterrestrial intelligence, for our expectations of what it will be like when we find it?

Additional Information:

(A) My interest is in the diversity of intelligence (SETI goal #1). This is not the question of how many intelligent species there might be but rather the question of how diverse – how different from us and from each other – we can expect the various intelligent species we encounter to be. (There is also an indirect connection with the issue of communication (SETI goal #2).)

(B) The data set required for the proposed empirical study (above) does not exist yet. The data would need to be assembled from the primary literature, presumably by a small team of postdocs and graduate students.

References:

[1] McShea, D.W. 2017. Logic, passion, and the problem of convergence. Journal of the Royal Society Interface Focus 7: 20160122. http://dx.doi.org/10.1098/rsfs.2016.0122

[2] Simpson, C. 2012. The evolutionary history of division of labour. Proceedings of the Royal Society B: Biological Sciences 279 (1726): 116-121.