



Profiling nonhuman intelligence: An exercise in developing unbiased tools for describing other “types” of intelligence on earth[☆]



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ABSTRACT

Intelligence has historically been studied by comparing nonhuman cognitive and language abilities with human abilities. Primate-like species, which show human-like anatomy and share evolutionary lineage, have been the most studied. However, when comparing animals of non-primate origins our abilities to profile the potential for intelligence remains inadequate. Historically our measures for nonhuman intelligence have included a variety of tools: (1) physical measurements – brain to body ratio, brain structure/convolution/neural density, presence of artifacts and physical tools, (2) observational and sensory measurements – sensory signals, complexity of signals, cross-modal abilities, social complexity, (3) data mining – information theory, signal/noise, pattern recognition, (4) experimentation – memory, cognition, language comprehension/use, theory of mind, (5) direct interfaces – one way and two way interfaces with primates, dolphins, birds and (6) accidental interactions – human/animal symbiosis, cross-species enculturation. Because humans tend to focus on “human-like” attributes and measures and scientists are often unwilling to consider other “types” of intelligence that may not be human equated, our abilities to profile “types” of intelligence that differ on a variety of scales is weak. Just as biologists stretch their definitions of life to look at extremophiles in unusual conditions, so must we stretch our descriptions of types of minds and begin profiling, rather than equating, other life forms we may encounter.

COMPLEX (Complexity of Markers for Profiling Life in EXobiology) offers a new approach to profile a variety of organisms along multiple dimensions including *EQ* – *Encephalization Quotient*, *CS* – *Communication Signal complexity*, *IC* – *Individual Complexity*, *SC* – *Social Complexity* and *II* – *Interspecies Interaction*. Because Earth species are found along a variety of continuums, defining an intelligence profile along these different trajectories rather than comparing them only to human intelligence, may give us insight into a potential tool for quickly assessing unknown species. The application of profiling nonhuman species, out of world, will be both observational and potentially interactive in some way. Using profiles and indicators gleaned from Earth species to help us develop profiles and using pattern recognition, modeling and other data mining techniques could help jump start our understanding of other organisms and their potential for certain “types” of intelligence.

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1. Introduction

Measures of intelligence, based on human criteria such as language features, have previously been described for complex social mammals including primates, dolphins, vervet

monkeys, prairie dogs, to name a few. Complex syntax, semantics and referential signal use has been found in many species. Studies of alarm calls in wild vervet monkeys [1], ground squirrels [2], and prairie dogs [3] have revealed elements of symbolic referential communication and competence. Similarly, laboratory studies of intra and interspecies referential communication and competence have revealed both semantic and syntactic understanding in common and pygmy chimpanzees [4] and bottlenose dolphins [5]. Dolphins, a non-terrestrial and most alien of social mammals, have the second largest encephalization quotient and complex cognitive abilities [6,7] and have a variety of mechanisms of information transfer [8] and teaching mechanisms [9].

Although human intelligence may be driven by complex social structure [10], non-mammals also show abilities that in some cases rival social mammals and include tool use and social skills (e.g. corvids (crows) [11]; ants, [12]). The social intelligence hypothesis has been challenged relative to other non-social forces that may also drive intelligence [13] suggesting a need for a non-human biased definition and measure of intelligence. This will be especially critical in our search for life beyond Earth and with alien species that have potentially evolved on other planets and under different environmental and social pressures. This will be relevant whether we decide to identify other “types” of intelligence to simply coexist with (ecologically), to interact with (symbiosis/mutual goals) or to potentially dialog with us (interaction/communication).

We currently propose to recognize signatures of life in Astrobiology on different scales including atomic, molecular, microfossils, macroscopic and planetary. How then will we recognize intelligence? Intelligence may be diverse in expression or different by type, degree, or scale. The Myers-Briggs psychology types (4 dimensions – Extrovert/Introvert, Sensing/Feeling, Thinking/Intuitive, Perceptive/Judgmental) ESIJ, EFIP, is an example of scaling on multiple dimensions and is utilized for typing complex human aspects.

This paper describes a multi-dimensional exercise to profile and assess different types of intelligence based on aspects of physical, social, and intellectual abilities.

2. Materials and methods

A Multi Dimensional exercise was developed called *COMPLEX: COMplexity of Markers for Profiling Life in EXobiology*. Measures in five dimensions, from physical to global properties, were used including (1) *EQ – Encephalization Quotient* (neural complexity), (2) *CS – Communication Signals* (sensory modalities), (3) *IC – Individual Complexity* (personalities), (4) *SC – Social Complexity* (group/solitary living) and (5) *II – Interspecies Interaction* (external relationships).

Taxa used were based on categories established by Dr. Lori Marino and Dr. Kathryn Denning on the Astrobiology website: intelligence.seti.org/pages/. These included *Vertebrates* (ex. Marine Mammal)-Cetaceans – DOLPHIN thought to have a high encephalization quotient, complex communication, associations, and big brains, *Invertebrates* (ex. Marine Invertebrate)-Cephalopods – OCTOPUS thought to have associative learning, tameness, exploratory behavior, *Invertebrates* (ex. Social Insect-Arthropods – BEE) thought to have collective intelligence, symbolic waggle dance, counting, learning, *Microbes* – (ex. Bacteria – GENERAL) thought to have complex behavioral responses w/o evolving complex brains, highly integrated, and *Machines* (ex. A.I. – GENERAL) demonstrated by neural networks, computational power, and algorithms.

Since most criteria for human intelligence emphasizes language, cognition and numerical competence, other dimensions of information processing were used to scale organisms in this exercise. Scoring of these criteria did not necessarily minimize anthropocentric bias for intelligence, but it did de-emphasize the sole importance of cognition or production of a language as the ultimate measure of intelligence as an attempt to broad our concept of “types” of intelligence. These scales address the importance of multiple features and skills, across multiple dimensions, which may be relevant to profile nonhuman types of intelligence.

Each category was scored by experts in the taxa, based on the own knowledge base, on four attributes on a scale of 1–10 (highest) and zero if no data were available. Experts scored zero or N/A if they did not feel qualified to score. Experts were then queried as to the difficulties of scoring

Table 1

Average scores generated from four attributes within five categories including: encephalization quotient, communication signal complexity, individual complexity, social complexity and interspecies interactions.

EQ=Encephalization Quotient and other Physical Measures				
Brain/head/body ratio	Neural density	Neural specializations	Convolution	Totals
10	9	10	10	EQ=39
CS=Communication signals and their complexity				
Sensory modalities/cross-modal	Natural repertoire	Information theory	Symbolic/synchrony/coordination	
8	7	5	5	CS=25
IC=Individual complexity and the role of the one				
Personality/tendencies	Role of individual	Leadership	Role flexibility	
2	2	2	1	IC=7
SC=Social complexity of the group/society				
Group living	Alliances/cooperation	Network variation	Culture/social learning	
9	9	5	7	SC=30
II=Interspecies Interactions and Openness to other Species				
Natural interactions	Cross-species altruism	Sensory gap to humans	Enculturation	
8	6	8	6	II=28

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