Concept Paper

De-Anthropomorphizing the Mind: Life as a Cognitive Spectrum: A Unified Framework for Biological Minds

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Abstract: The nature of cognition, intelligence, and consciousness has long been a topic of debate across multiple disciplines, often constrained by anthropocentric perspectives. This paper challenges these traditional views by proposing a unifying framework that considers cognition as a broad spectrum encompassing all living organisms, from bacteria to humans. By de-anthropomorphizing the concept of the mind, we explore cognition as an emergent process that manifests through diverse mechanisms, including neural and non-neural systems. We examine the continuum of sentience, intelligence, and awareness across various biological entities, emphasizing their role in adaptive behavior and decision-making. The study further discusses the implications of this framework for artificial intelligence, philosophy, and ethics, highlighting the necessity of precise conceptual definitions. Ultimately, this work aims to refine our understanding of intelligence and cognition, fostering interdisciplinary dialogue and advancing the development of artificial cognitive systems.

Keywords: cognition; sentience; intelligence; awareness/consciousness; mind

Introduction

The recent impressive advancements in AI once again bring to the forefront the question of our understanding of intelligence in humans, animals, and artificial systems. It is evident that our current definitions of fundamental terms such as cognition, sentience, intelligence, awareness/consciousness, and mind are insufficient, often leading to confusion and conceptual muddles.

The debate continues: some claim that ChatGPT is already conscious, while others argue that this is impossible, given its lack of the fundamental cognitive architecture that enables human consciousness. Yet, ChatGPT can engage in conversation with humans in an impressively convincing manner. If the Turing test were applied at this stage, it would likely pass as intelligent. But is it conscious? Are animals conscious? What about bacteria?

Apart from a few panpsychists who believe that consciousness permeates the universe, the rest of us struggle with vague and inconsistently defined notions of intelligence.

The aim of this paper is to carefully explore the concepts of cognition, sentience, intelligence, awareness/consciousness, and mind and to present a unifying model applicable to all living beings. Since nature serves as a source of inspiration for technological development, introducing clearer conceptual definitions may foster novel approaches to understanding and advancing artificial intelligence.

Different Kinds of Living Organisms Possess Different Forms of Cognition, Sentience, Intelligence, and Awareness/Consciousness

Cognition, intelligence, and consciousness exist on a continuum, with different life forms displaying distinct abilities shaped by their biology, evolution, and environment.

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Instead of thinking in binary terms (conscious vs. non-conscious, intelligent vs. non-intelligent), we can explore how various organisms display different cognitive traits suited to their ecological roles.

Table 1. A Spectrum of cognition, intelligence, and awareness across life.

Type of organism	Type of cognition	Type of intelligence	Type of awareness
Bacteria	Distributed, chemical-based cognition (quorum sensing, gene regulation)	Group-level intelligence (colony adaptation)	Minimal awareness—environmental sensing, no subjective experience
Fungi	Network-based, electrical signal processing, decentralized information integration	Memory-like responses, decision-making in resource allocation	Proto-awareness—responsive but not experiential
Plants	Chemical and electrical signaling, adaptive growth	Environmental intelligence—adjusting structure based on stimuli	Limited awareness—sensitive to light, gravity, and touch but no subjective experience
Insects & simple animals	Neural-based cognition, instinct-driven behavior	Learning-based intelligence, simple problem-solving	Primary awareness—moment-to-moment experience, but no reflective thought
Cephalopods (octopuses, squids)	Complex, distributed neural cognition	High intelligence, tool use, learning, problem-solving	Likely conscious—flexible, independent decision-making
Birds & mammals	Advanced neural cognition, social learning, memory	Social intelligence, problem-solving, tool use, reasoning	Conscious awareness—complex emotions, memory, self-recognition in some
Great apes & humans	Abstract thought, symbolic reasoning, long-term planning	Metacognition, cultural learning, language	Self-awareness, imagination, introspection, subjective experience

Definitions of Cognition, Intelligence, Sentience, Awareness → Consciousness and Mind, for All Living Organisms in a Unified Framework

To create definitions that apply to all life forms, we ensure they are broad enough to include both neural and non-neural organisms, precise enough to differentiate between levels of complexity and grounded in biological processes rather than anthropocentric assumptions.

Cognition

Definition. Cognition is the process by which an organism acquires, transforms, stores, and uses information to regulate its behavior and interactions with the environment.

Cognition exists in all life forms—from bacteria to humans. It includes information processing, sensory input, and response coordination. It does not require a brain—fungi, plants, and bacteria exhibit cognition through chemical and electrical signaling. For example, bacteria use quorum sensing to make group decisions. Fungi transmit electrical signals across their mycelial networks. Animals process sensory input through neural systems.

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Sentience

Definition. Sentience is the capacity of an organism to have valenced responses—meaningful experiences of preference for beneficial conditions over harmful ones, that in the first step is valenced response that distinguishes "good" from "bad".

Sentience reflects a preference toward beneficial states. The organism does not just react but internalize inputs of individual/subjective experience. Sentience ranges from basic (bacteria avoiding toxins and move toward nutrients; insects exhibit pain-like responses to injury) to complex (emotions like joy and fear in mammals). Sentience does not require language or self-awareness.

Experiences are not neutral; they are perceived as 'good' or 'bad,' eliciting valenced responses. Sensory-based awareness implies that the organism processes sensory information in a way that affects behavior beyond pure reflexes. All living organisms possess a degree of sentience. A bacteria processes information from the environment (cognition) and valuate it in terms of good/bad or attractive/repulsive. Sentience is complex in organisms with nervous system—but simpler forms exist already in non-neural organisms. All animals are sentient, but only some have self-awareness.

Table 2. Types of "sentience" across life.

Life form	Type of valenced response	Type of sentience
Bacteria	Chemotaxis (moving toward nutrients, away from toxins)	Minimal sentience (goal-directed behavior)
Protists	Learning from negative stimuli, avoidance behavior	Sensory-based sentience (no memory, but adaptive response)
Fungi	Memory-like growth preferences, adaptive decision-making	Decentralized valence-based awareness
Plants	Growth toward light (positive valence), toxin avoidance	Limited sensory awareness
Insects & Simple Animals	Active decision-making based on reinforcement	Basic sentience (experiences pain/pleasure)
Birds & Mammals	Complex emotions, social intelligence	Higher-order sentience (affective experiences)

Intelligence

Definition. Intelligence is the ability of an organism to learn, solve problems, and adapt behavior based on experience or environmental changes.

Intelligence involves learning, problem-solving, and flexible responses. It is expressed on the individual level (octopus learning a task) and collective level (bacteria in biofilms adapting to antibiotics). It does not require a brain—fungi and plants exhibit intelligence through adaptive behavior. For example, octopuses are capable of problem-solving and they use tools. Bees learn and remember complex foraging routes. Fungi adjust their growth patterns based on past and present nutrient availability.

Awareness/Consciousness—Continuum

Definition. Awareness → consciousness continuum is the ability of an organism to integrate sensory information, maintain a continuous state of responsiveness, and interact with the environment in a structured way.

It ranges from basic environmental awareness to self-awareness and consciousness. It does not require thought or introspection—even bacteria and fungi are "aware" of their surroundings.

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Awareness exists on a spectrum: simple organisms have sensory awareness, while complex organisms develop complex self-awareness and consciousness.

Bacteria detect chemical gradients and adjust behavior. Fungi sense nearby plants and redirect growth. Dogs experience emotions and respond to social cues. Humans engage in self-reflection.

Mind

Just like cognition, sentience, intelligence, and awareness → consciousness, the term "mind" is currently ill-defined and anthropocentric. If we want definitions that apply to all living organisms, and generalize to machines, we need generalized but precise explanations that allow for different levels of complexity across species.

Definition. Mind is the activity of an organism that processes information, integrates sensory input, regulates internal states, and generates adaptive responses.

The **mind is the totality of cognitive, sentient, intelligent, and conscious functions** working together.

This definition points out the dynamical and multi-tasking aspects of mind, which includes information processing (like cognition), regulation of behavior and adaptation (like intelligence) and integration of internal and external signals (like awareness).

The key features of a mind are information processing, signal integration, behavior regulation and adaptation. Mind is not present only in a physical brain—it includes all information-processing mechanisms. It applies to both centralized (brains) and distributed/decentralized (fungal networks) systems. It exists in all living systems as a means they regulate themselves.

A "mind" does not necessarily require reflection or self-awareness—it can be purely functional. Minds exist on a continuum—from decentralized systems (fungi, bacteria) to highly centralized brains (humans, apes). As fungi, plants, and bacteria process information adaptively, they have basal forms of mind, even if they lack subjective experience.

For example, fungal networks process information about nutrients and threats. Insect colonies function as "collective minds" that solve problems. Human brains engage in complex reasoning and creativity.

All biological organisms consist of cells, so “cellular minds” are the building blocks for all living minds, including human. Living organisms at different levels of complexity possess different forms of cognition and intelligence adapted to their environment. Awareness exists in many forms—from simple environmental sensing to deep introspection. Brains are NOT required for cognition—many living systems process information in distributed ways. Consciousness may not be binary but a continuum, with different levels of experience in different organisms.

The Unified Model of Biological Minds

Table 3. Unified model of mind.

Concept	Definition	Applies to	Key function
Cognition	Acquiring, processing, and using information	All living organisms	Guides behavior based on environmental data
Sentience	The ability to have valenced responses (seeking beneficial conditions, avoiding harm)	Many organisms, from bacteria to mammals	Enables organisms to optimize survival
Intelligence	Learning, problem-solving, and adaptation	Organisms that adjust behavior based on experience	Enhances survival through decision-making

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Awareness → consciousness	Integration of sensory information for structured responsiveness	All organisms, in different degrees	Maintains interaction with the environment
Mind	The system that processes information, integrates sensory input, and regulates internal states	All organisms with organized behavior	Structures perception and decision-making

A Diversity of Minds

Instead of asking "Which organisms are conscious?" or "Which organisms are intelligent?", the "diverse minds" approach suggests a more nuanced view. Different organisms exhibit different forms of cognition—adapted to their ecological needs. Intelligence emerges in multiple ways—through centralized brains or decentralized networks. Consciousness is a spectrum, without a strict boundary—with varying degrees of "subjective" (individual) experience.

How Cognition, Sentience, Intelligence, Awareness → Consciousness Relate to the Mind

Table 4. Relations of cognition, intelligence, and awareness across life.

Concept	Definition	Role in the mind
Cognition	Information processing and response to stimuli	Forms the foundation of the mind—allows organisms to perceive and react
Sentience	Valenced responses, seeking beneficial conditions, avoiding harm	Adds subjective evaluation to perception
Intelligence	Learning, problem-solving, and adaptation	Enhances the mind's ability to make decisions and adjust to change
Awareness → consciousness	Awareness, subjective experience, perception of self	Adds the experiential layer—mind becomes not just functional but "aware"
Mind	The total system that integrates cognition, intelligence, and consciousness	The dynamic process that enables organisms to perceive, think, and experience

Different Life Forms in the Unified Mind Model

Table 5. Cognition, intelligence, consciousness and mind in different life forms.

Organism Type	Cognition	Intelligence	Consciousness	Mind
Bacteria	quorum sensing	colony adaptation	good/bad (for a bacterium)	minimal regulatory system
Fungi	electrical signaling	adaptive memory-like behavior	Proto-consciousness (environmental awareness)	distributed mind
Insects	neural processing	learning, navigation	sensory experience	functional but limited mind

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Cephalopods	complex neural network	problem-solving, tool use	possible self-awareness	highly flexible mind
Mammals	advanced neural processing	social learning, reasoning	emotional and sensory awareness	fully conscious, reflective mind

Even simple life forms have a "mind" if we define it as the system integrating level of cognition, intelligence, and awareness. Evolution leads to higher minds developed with greater intelligence and more complex consciousness.

The Mind as an Emergent Phenomenon

Instead of being a physical object, the mind is an emergent process—it arises when cognition, sentience, intelligence, and consciousness interact in a dynamic, self-regulating way. This means that minds can exist in decentralized systems such as fungi and bacteria colonies. Minds can exist without self-awareness as in plants and insects. The complexity of a mind depends on the depth of cognition, intelligence, and consciousness.

Table 6. Functions of cognition, sentience, intelligence, awareness/consciousness and mind.

Concept	Definition	Function
Cognition	Information processing and response to stimuli	Allows organisms to sense and react
Sentience	The ability to valenced responses good/bad	Adds "value"—reactions are not just mechanical but have an evaluative dimension
Intelligence	Learning, problem-solving, and adaptation	Allows organisms to adjust behavior based on past experience
Awareness → consciousness	Subjective awareness, perception of self	Allows organisms to integrate experience into a unified sense of existence
Mind	The emergent system integrating all these processes	The total cognitive-affective system of an organism

As biological minds exist on a spectrum, we can categorize organisms by the depth of their mind-related capacities.

Table 7. The properties of mind in different organisms.

Organism Type	Cognition	Sentience	Intelligence	Consciousness	Mind
Bacteria	quorum sensing	valenced behavior	colony adaptation	basic awareness	self-regulating system
Fungi	electrical signaling	proto-sentience	adaptive decision-making	environmental awareness &	distributed mind

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				proto-* consciousness	
Plants	Chemical signaling, memory-like responses	Limited valenced responses	Adaptive growth strategies	Environmental awareness	Decentralized mind
Insects	neural processing	experience pain	learning, navigation	sensory experience	functional limited mind
Cephalopods	complex neural network	strong sentience emotion-like states	problem-solving, tool use	possible self-awareness	highly flexible mind
Mammals	advanced neural processing	Deep sentience (emotions, social bonds)	social learning, reasoning	emotional and sensory awareness	fully conscious, reflective mind

*"proto" here stands for early, first, from which other similar things develop.

Instead of asking "Which organisms have minds?", a better question is: "What kind of mind does an organism have?" The mind is not an object but a process—one that exists in different degrees across all life forms.

Conclusion

The exploration of cognition, intelligence, sentience, and consciousness across biological systems shows that the mind is not a binary phenomenon but a continuum of cognitive processes adapted to different ecological and evolutionary contexts. By moving beyond anthropocentric definitions, we can recognize diverse forms of intelligence and awareness in organisms ranging from bacteria to mammals, each exhibiting unique mechanisms of information processing, including decision-making, and adaptive behavior.

This perspective challenges traditional assumptions about mind and what it means to be "intelligent" or "conscious" and has profound implications for multiple disciplines. In biology, it encourages a more nuanced understanding of cognition across species. In artificial intelligence, it inspires new approaches to machine learning and autonomous systems by recognizing intelligence beyond centralized neural structures. In philosophy and ethics, it invites reconsideration of considerations for non-human life forms based on their capacity for experience and adaptation.

Future research should focus on empirically testing the proposed layered model of cognition and intelligence in both biological and artificial systems. By refining our definitions and methodologies, we can develop a more comprehensive framework that not only enhances our understanding of natural intelligence but also informs the design of future intelligent technologies.

Ultimately, de-anthropomorphizing the mind allows for a richer, more inclusive approach to studying cognition—one that respects the complexity and diversity of minds across the natural world.

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