



Bottlenose dolphins (*Tursiops truncatus*): social intelligence, communication and cognition

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Abstract. This mini-review synthesizes current knowledge on the cognitive, social, and communicative capacities of bottlenose dolphins (*Tursiops truncatus*), positioning them within broader comparative frameworks of animal cognition. Drawing on both laboratory and field research, the paper highlights dolphins' advanced representational abilities, including symbolic language comprehension, cross-modal perception, and strong memory systems. Evidence for abstract concept learning, imitation, innovation, and self-related cognition suggests a high degree of behavioral flexibility and elements of self-awareness. The review further examines dolphin social intelligence in the context of complex, multi-level social structures characterized by long-term bonds, alliances, and cooperative interactions. Special emphasis is placed on joint attention, perspective-taking, and the interpretation of human communicative cues, where dolphins demonstrate abilities comparable to or exceeding those of some primates. Communication is analyzed as a context-dependent and flexible system, with vocal and gestural signals modulated by social roles, environmental conditions, and human interaction. Additionally, the paper discusses cooperative behavior and its methodological challenges, emphasizing the role of personality traits and social tolerance in shaping cooperative outcomes. The integration of cognition, communication, and cooperation is framed within the "tripartite complex" hypothesis, supporting the idea that these domains co-evolve in socially demanding environments. Finally, the review addresses implications for comparative cognition, evolutionary theory, and animal welfare, particularly in relation to enrichment practices.

Key Words: animal cognition, cognitive ecology, comparative cognition, cooperation, joint attention, self-awareness, social behavior, vocalization.

Introduction. The most widely used animal models in ecological studies of social intelligence, communication and cognition range from invertebrates with simple nervous systems to highly social mammals. Simple model organisms such as *Caenorhabditis elegans*, *Drosophila* fruit flies and social insects (especially bees and ants) are central because they display rich social behaviors, including social dominance, group decision-making, and social learning, while allowing precise genetic and neural manipulation (Dukas & Ratcliffe 2009; Sokolowski 2010; Simons & Tibbetts 2019). Among vertebrates, laboratory mice and rats are classic models for social behavior and emotional contagion, but their domestication raises questions about how well standard tests capture ecologically valid social interactions such as natural dominance hierarchies and social transmission of information about danger (Kondrakiewicz et al 2018). Primates, particularly macaques and marmosets, are key models for higher-level social cognition, including theory of mind-like abilities, sensitivity to social complexity, and human-relevant social cognitive tasks (Gómez 2021; Samandra et al 2022; Shultz & Dunbar 2022; Schwob et al 2025). Broader ecological and comparative work also relies heavily on birds and mammals to study social learning, collective decision-making, and the links between social structure, communication and general intelligence, for example in corvids, flocking birds, schooling fish, and socially complex mammals such as big cats and other primates (Shettleworth 2001; Petrescu-Mag 2007ab; Couzin 2009; Sewall 2015; Van Schaik et al 2016; Peckre et al 2019; Kashetsky et al 2021). More recently, non-avian reptiles and socially complex rodents like the degu have emerged as valuable models for testing cognitive ecology and the effects of social environment on learning, memory and

even neurodegenerative processes in naturalistic contexts (Rivera et al 2016; Szabo et al 2020).

Bottlenose dolphins are a flagship species for the study of animal cognition because they combine complex social lives with strikingly flexible learning and communication. Research in laboratories and in the wild portrays them as socially sophisticated mammals whose abilities in cooperation, social learning and even forms of self-awareness make them central to debates on the evolution of animal minds (Pack & Herman 2006; Herman 2010; Seyfarth & Cheney 2015; Friedman 2017; Roberts & Roberts 2019).

The aim of this mini-review is to critically synthesize current empirical and theoretical research on the social intelligence, communication, and cognitive abilities of bottlenose dolphins (*Tursiops truncatus*), and to evaluate their significance as a non-primate model for understanding the evolution of complex cognition in socially demanding environments.

Cognitive Capacities and Representational Skills. Long term laboratory work shows that bottlenose dolphins possess finely tuned sensory systems, strong short-term memory and rich concept learning abilities (Herman 2010). They discriminate subtle auditory and visual differences, recognize objects across vision and echolocation, and remember lists of items. In artificial gestural or acoustic “languages,” dolphins correctly interpret novel five-word sentences, processing both word meanings and their order, and use words referentially to report whether an object is present or absent (Herman 2010).

They also show sophisticated imitation: they vocally mimic novel sounds and reproduce human and dolphin actions, and can follow an abstract “imitate” command, including coordinating synchronous behaviors with a partner (Herman 2010). Training on the conceptual cue “innovate” reveals dolphins can generate diverse, original behaviors, with individual differences in fluency, flexibility and elaboration, suggesting a capacity for creative problem solving and intrinsic enjoyment of cognitive challenge (Yeater et al 2024).

Self-related cognition appears in their ability to report on their own recent behavior and to respond appropriately when parts of their own body are symbolically referenced, indicating a form of conscious self-monitoring that goes beyond simple stimulus–response patterns (Herman 2010). This aligns with broader comparative work linking sociality and the emergence of self-recognition and self-awareness across species (Plotnik et al 2006; Lei 2023) (Table 1).

Table 1
Core cognitive abilities supporting dolphin social life (summarized by Consensus, 2026)

<i>Domain</i>	<i>Demonstrated abilities in Tursiops truncatus</i>	<i>Citations</i>
Memory & representation	Short-term memory for lists; cross-modal object recognition	(Herman 2010)
Symbolic “language” use	Understand 5-word sentences; semantic + syntactic processing; referential use	(Herman 2010)
Abstract concepts	“Imitate”, “innovate”, behavioral synchrony	(Herman 2010; Yeater et al 2024)
Self-related cognition	Awareness of recent actions, symbolically cued body parts	(Herman 2010; Lei 2023)

Wild bottlenose dolphins live in intricate social networks that include long-term relationships, multi-level male alliances and flexible coalition formation (Pack & Herman 2006; Seyfarth & Cheney 2015; Friedman 2017). This social complexity fits major theories (social intelligence, social brain and communicative roots hypotheses) that link demanding social environments to advanced cognition (Seyfarth & Cheney 2015; Fernald 2017; Friedman 2017; Roberts & Roberts 2019).

A central feature of dolphin social cognition is joint attention. Experimental work shows dolphins understand direct and cross body human pointing, dynamic and static points and gaze cues in object choice tasks, and they use the geometry and referential character of these cues to locate objects or destinations (Pack & Herman 2006; Herman 2010). They can follow sequences of points that instruct them to transport one object to another, produce pointing themselves, and modulate their signals depending on audience attention, suggesting an appreciation of what others can see and possibly what others believe in joint attention contexts (Pack & Herman 2006). In several aspects of joint attention, their skills meet or surpass those demonstrated in apes (Pack & Herman 2006), highlighting convergent evolution of high-level social cognition in very different lineages.

Cooperation has been explored with rope pulling tasks requiring two dolphins to act together to receive food (King et al 2016; Bagley et al 2020; Ostojić 2020; Bigiani & Pilenga 2023). Some work reports spontaneous cooperative solutions and apparent coordination signals, but other analyses argue that task design may confound cooperation with competitive “tug of war,” and that vocalizations interpreted as cooperative cues might instead be linked to aggression (King et al 2016; Ostojić 2020). More recent studies shift focus from “can they solve this exact task?” to how personality and social tolerance shape cooperative attempts: traits like playfulness, curiosity, affiliation, agreeableness and extraversion predict greater interaction with cooperative apparatuses and partners, even when full technical cooperation is not achieved (Bagley et al 2020). Cognitive enrichment based on cooperative rope pulling can reduce intolerance and increase play, suggesting that engaging dolphins in cognitively demanding, collaborative contexts fosters more harmonious social dynamics (Bigiani & Pilenga 2023).

These findings fit broader comparative analyses of cooperative problem solving, which warn against assuming that such tasks necessarily tap unique “social modules” rather than more general cognitive mechanisms applied in social settings (Ostojić 2020). In this perspective, dolphins’ rich social skills emerge from domain general learning and representation operating within highly demanding social ecologies (Seyfarth & Cheney 2015; Ostojić 2020; Screpanti et al 2025).

Communication, Vocal Flexibility and Human–Dolphin Interaction. Dolphin communication is both flexible and socially embedded, making it a prime case for hypotheses that link social and communicative complexity (Seyfarth & Cheney 2015; Kershenbaum & Blumstein 2017; Roberts & Roberts 2019). In laboratory studies, dolphins understand human pointing gestures and may generalize from the referential function of their own echolocation beam to interpret pointing as indicating external targets (Pack & Herman 2006; Herman 2010). They also spontaneously use pointing like behaviors with humans, adjusting their production to whether an observer is attending, which fits criteria for intentional, referential signaling central to cognitively complex communication (Pack & Herman 2006; Roberts & Roberts 2019).

In managed-care environments, detailed acoustic monitoring across training, feeding, play and unstructured periods shows strong modulation of vocal activity by social context. Dolphins produce significantly more whistles and pulsed sounds during structured activities, particularly play sessions, consistent with these signals supporting social and exploratory interactions (Screpanti et al 2025). Environmental enrichment that demands cognitive and cooperative engagement not only alters behavior, but likely reshapes communication patterns as social tolerance and play increase (Lyn et al 2020; Bigiani & Pilenga 2023; Screpanti et al 2025).

Field research in Laguna, Brazil, reveals that dolphins engaged in long standing cooperative foraging with artisanal fishers form a distinct social community whose whistle types and acoustic parameters differ from noncooperative conspecifics (Romeu et al 2017). Cooperative dolphins, especially outside direct human interaction, use shorter whistles with higher frequencies and more inflections than noncooperative dolphins, and whistle type frequencies shift depending on whether dolphins forage with or without humans (Romeu et al 2017). These patterns suggest that vocal repertoires are finely

tuned to social roles and foraging tactics, possibly promoting cohesion and coordination within specific communities.

Across these settings, dolphin vocal behavior exemplifies the proposed “tripartite complex” in which communication, cooperation and cognition are tightly intertwined: cognitively demanding social environments select for flexible, intentional communication, which in turn supports the maintenance of complex social systems (Seyfarth & Cheney 2015; Fernald 2017; Kershenbaum & Blumstein 2017; Roberts & Roberts 2019) (Table 2).

Table 2

Examples of context dependent social communication in dolphins (summarized by Consensus, 2026)

<i>Context / community</i>	<i>Key vocal or gestural features</i>	<i>Citations</i>
Human pointing and gaze	Comprehension of direct/cross-body points; production of points	(Pack & Herman 2006; Herman 2010)
Cooperative foraging with fishers	Distinct whistle structure; community-specific whistle profiles	(Romeu et al 2017)
Structured activities & play (zoo)	Highest rates of whistles and pulsed sounds during play/training	(Lyn et al 2020; Bigiani & Pilenga 2023; Screpanti et al 2025)

Dolphins and the Comparative Study of Animal Cognition. Bottlenose dolphins are now central to comparative frameworks on the evolution of social cognition and self-awareness. Their demonstrated self-related capacities (awareness of own actions and body, mirror self-recognition in closely related work) place them among a small set of species—including great apes and elephants—that pass demanding self-recognition criteria, a pattern strongly associated with high sociality (Plotnik et al 2006; Herman 2010; Lei 2023).

More generally, social intelligence theories propose that advanced skills such as individual recognition, joint attention, perspective taking and flexible signaling arise when “simpler” strategies can no longer manage the complexity of social life (Seyfarth & Cheney 2015; Fernald 2017; Friedman 2017; Roberts & Roberts 2019). Dolphins, with multi-level alliance structures arguably rivaling or exceeding those of many primates (Friedman 2017), offer a non-primate model to test whether similar cognitive architectures evolve under comparable social pressures. Their case also highlights key methodological challenges: distinguishing cooperation from competition, avoiding social species bias in selecting study animals, and carefully parsing which aspects of a task truly require specialized social cognition rather than domain general learning (Seyfarth & Cheney 2015; Ostojić 2020).

In welfare and human–animal interaction research, dolphins’ cognitive sophistication has direct implications. Enrichment that is cognitively complex or socially cooperative can enhance play and reduce intolerance, but can also have unintended negative effects if not carefully evaluated, underscoring the need for systematic, evidence-based enrichment programs that respect the animals’ social and cognitive needs (Lyn et al 2020; Bigiani & Pilenga 2023; Screpanti et al 2025).

Conclusions. Overall, the body of evidence reviewed reinforces the status of bottlenose dolphins as one of the most cognitively sophisticated non-human species. Their ability to integrate advanced representational skills with flexible communication and complex social behavior illustrates a highly adaptive cognitive system shaped by social and ecological pressures. Importantly, many of these capacities—such as joint attention, referential signaling, and elements of self-awareness—parallel those observed in primates, supporting the concept of convergent evolution of intelligence across phylogenetically distant lineages.

At the same time, the review highlights critical methodological and conceptual challenges. Distinguishing genuine cooperation from competitive or individually driven strategies remains difficult, and there is a need for more ecologically valid experimental designs. Furthermore, the tendency to interpret dolphin cognition through anthropocentric frameworks should be approached cautiously, with greater emphasis on species-specific sensory modalities and ecological contexts.

From an applied perspective, the findings underscore the importance of cognitively and socially enriched environments in managed care. Well-designed enrichment programs can enhance social tolerance and behavioral diversity, but they require rigorous evaluation to avoid unintended consequences. Future research should prioritize integrative approaches that combine behavioral, cognitive, and acoustic data across both wild and controlled settings, enabling a more comprehensive understanding of how communication, cognition, and sociality interact in shaping dolphin behavior.

Conflict of Interest. The authors declare that there is no conflict of interest.

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