The manner in which any animal, including a human, behaves depends on the information it receives from its environment. The capacity to use this information depends on the animal’s sensory processes, perception, learning, and recall. Consequently, the animal’s response depends on its ability to acquire, process, store, and recollect such information. The capacity of animals in diverse species to use this information to make decisions in the present, recall the past, and plan for the future has become a point of convergence for the study of animal cognition (Shettleworth, 2010). This has led to an interdisciplinary approach for scientists studying the mechanisms that underlie cognitive processing (Wasserman and Zentall, 2006) and for those studying the evolution of animal cognition (Bekoff et al., 2002).

Comparative studies show that many nonhuman animals share aspects of cognition and processing with humans (Shettleworth, 2010). More importantly, most scientists accept the view that the underlying cognitive architecture and processes are products of natural selection, which allowed animals to face ecological and environmental challenges (Real, 1993; Kamil, 1998; Dukas and Ratcliffe, 2009). This comparative and ecologically based approach is the starting point for the authors of the papers in this special issue on animal cognition.

The goal of this special issue was to use a comparative approach to provide insight into the cognitive processes animals use to solve problems, remember the past, shape decisions in the present, and anticipate events in the future. It is my hope and those of the contributors that the following papers can serve as a guide to research on the function, development, mechanisms, and evolution of animal cognition.

Beran et al. compared the judgments of relative numerosness in young children and chimpanzees Pan troglodytes. The authors used identical procedures that allowed the subjects to respond to two sequentially presented sets of items. Beran and colleagues discovered that chimpanzees and older children performed better than younger children in most presentations. These researchers concluded that chimpanzees and children share an approximate number sense that is reflected through analog magnitude estimation when comparing quantities.

Yocom and Boysen conducted several experiments to assess the understanding of tool relationships in captive chimpanzees. The experiments tested nine enculturated chimpanzees on three versions of a support task, during which food rewards were presented in different experimental configurations. The authors reported data that provide strong support for the hypothesis that chimpanzees based their responses to the task on an understanding of tool use relationships.

Ferkin et al. examined the responses of meadow voles Microtus pennsylvanicus to over-marks. Over-marking is a form of olfactory communication that is widespread among many terrestrial mammals. Ferkin and colleagues determined how meadow voles respond to the overlapping scent mark of three different donors: the top-scent donor, the middle-scent donor and the bottom-scent donor of an over-mark. Voles spent more time investigating the mark of the top-scent donor than that of the either the middle- or bottom-scent donor. However, Ferkin and co-workers discovered that male and female voles differed in the values they appear to attach to each of the top-, middle-, and bottom-scent marks of an over-mark.

Crane and Mathis determined whether Ozark zigzag salamanders Plethodon angusticlavius could learn to locate foraging areas by using landmarks. Salamanders were trained to use small rocks as landmarks to locate patches within an arena containing food, blackworms. During testing, when no blackworms were present, trained salamanders spent significantly more time in the
area of the landmark than did control salamanders, suggesting that these animals have the capacity for spatial learning.

delbarco-Trillo and Johnston tested the hypothesis that losing a fight with a conspecific will affect future agonistic interactions that the loser may have with other conspecifics. They used male Syrian hamsters, *Mesocricetus auratus*, as the focal animals. The authors found that losing a dyadic encounter affected the response of that male to unfamiliar males. The loser was more likely to attempt to escape during subsequent encounters. delbarco-Trillo and Johnston’s results may explain why social status in many animals tends to be stable over time.

Kaplan examined pointing gestures in songbirds to determine whether it is an instrumental or a cognitively complex behavior. Kaplan did so by measuring the responses of Australian magpies *Gymnorhina tibicen* to a taxidermic model of a wedge-tailed eagle. Magpies were exposed in their territories to this model in an open condition, a sheltered condition, or a hidden condition. In the sheltered and hidden conditions, the discoverer simultaneously engaged in alarm calls and head pointing, and the other group members once assembled, adopted the same posture by pointing to the location of the intruder. Kaplan questions whether the group members interpret the signal and respond by altering their own behavior appropriate to the original stimulus or by imitating the first signaler.

Pérez et al. conducted a field study to determine if white-eared hummingbirds, *Hylocharis leucotis*, use locations or visual cues to avoid revisiting recently depleted flowers. The authors reported that hummingbirds remember the location and use visual cues to locate unvisited flowers. Pérez and co-workers also discovered that hummingbirds will use location if visual cues are not available.

Wilkinson et al. examined contagious yawning in the red-footed tortoise *Geochelone carbonaria* to determine if it is the result of non-conscious mimicry emerging through close links between perception and action or if contagious yawning is the result of empathy, involving the ability to engage in mental state attribution. Wilkinson and co-workers tested three hypotheses to distinguish between these mechanisms. They argue that contagious yawning in the red-footed tortoise is not likely to be the result of non-conscious mimicry emerging through close links between perception and action. Wilkinson and colleagues conclude that contagious yawning may involve complex social processes, such as empathy.

Carere and Locurto reviewed the interaction between animal personality and animal cognition. Based on their review, they suggest that personality profiles may be markers of different cognitive styles. Success or failure in cognitive tasks could affect different personalities differently. Developmental changes of personality profiles could be associated with cognitive performance.

D’Mello and Franklin provide a synthesis of the literature that allows them to create a comprehensive, computational, cognitive model of animal cognition, the LIDA model, which identifies important concepts and their interrelations. The authors expand on an existing ontology of concepts associated with cognitive processing in animals. D’Mello and Franklin argue that the LIDA model provides a computational framework that can be used to compliment empirical and theoretical work on animal cognition.

Schoech and colleagues review the short- and long-term effects of developmental corticosterone exposure on aspects of avian physiology, behavioral phenotype, cognition, and fitness. The authors show that response of the hypothalamo-pituitary-adrenal (HPA) axis to effectors that an individual experienced as an embryo or nestling is indicative of its response to effectors on the HPA axis as an adult. The authors show that corticosterone titers of young Florida scrub-jays *Aphelocoma coerulescens* could affect the personality, coping style, and fitness of these birds as adults.

Crystal and Foote provide a critique of information-monitoring in animals. They question the interpretations of previous studies that inferred that metacognition was used for information-seeking. The authors propose two alternative hypotheses that are sufficient to explain putative evidence for information-seeking in animals without positing metacognition. These alternative hypotheses rely on two relatively simple principles: First, an animal has a default “look before you go” response which supersedes random searches in space. Second, spatially guided behavior follows a default rule of “go where something good is.”

Leonard and Winsauer point out that although little is known about the role testosterone plays in learning and memory in males, recent studies have shown that testosterone and its metabolites can enhance a male’s performance on certain behavioral tasks, probably by exerting their effects on the cholinergic pathways. They also report that testosterone titers in males decline with age, albeit more gradually, and this decline has been correlated with impairment of certain cognitive tasks.
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