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Domestication and Behavioural Evolution: Convergent and Divergent Outcomes in Dogs and Cats

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Abstract. The domestication of cats and dogs through symbiotic pathways has introduced them into human space to reduce their fear and reactive attacks, providing them with opportunities to acquire human resources and social connections. For thousands of years, choices in these environments have resulted in convergent and divergent behavioral outcomes. This article combines evidence from behavior, neuroendocrine and genetic mechanisms, development, and contemporary ecology to explain why cats and dogs have similar adaptability to humans but different social motivations. Existing research demonstrates that dogs exhibit significant human centered social cognition, such as using pointing and gaze, as well as seeking help, which is supported by oxytocin related pathways and early socialization. Cats can also form stable attachments, follow human cues, recognize their own names, but they exhibit more context dependent seeking behavior and focus more on reward and fear regulation circuits. The developmental time and contemporary ecological environment further shape the adult phenotype through gene environment interactions. This evidence suggests that attachment ability and sensitivity to human cues are similar, but there are differences in cooperation and group organization. This article reveals how urbanization and management practices utilize the social motivations of specific species to improve welfare, conservation outcomes, and public health.

1 Introduction

Dogs (Canis familiaris) and cats (Felis catus) likely entered human society through a commensal pathway: tolerant individuals lingered at the edges of settlements, exploiting garbage or rodent-rich granaries[1]. In such niches, lower fearfulness and reactive aggression provided fitness dividends and laid the foundation for deeper social integration[2]. A suite of shared variations characterizing the domestication syndrome recurs across domesticated animals, linking changes in pigmentation, craniofacial morphology, stress responses, and behavior to alterations in neural crest development[2]. Dogs and cats are thus ideal contrasts in a common pathway: both successful commensal species differ in their ancestral social systems (wolves versus mostly solitary wildcats) and in the strength and direction of historical selection mediated by humans[1].

Behaviorally, dogs demonstrate robust human-oriented social cognition. Even with limited prior contact, puppies are better than hand-reared wolves at adapting to human pointing and gaze, and pet dogs readily alternate gaze between humans and difficult tasks, effectively seeking help[3,4]. Mutual gaze can reinforce attachment through oxytocin-related feedback[5]. Cats also form secure or insecure attachments with their owners, follow pointing, use human gaze, and recognize their own names[6,7]. However, their help-seeking behavior is generally less persistent and more context-dependent, with greater inter-individual variability, linked to early socialization and living conditions. At a mechanistic level, canine studies have linked oxytocin pathway variation (e.g., OXTR) to human-directed behavior, while feline genomics has highlighted selection within learning, reward, and fear regulation circuits[5,8].

A key gap lies in the need for a comprehensive cross species interpretation that links selection pressure with sensitive developmental windows, neuroendocrine and genetic regulatory factors, behavioral phenotypes, and ecological feedback. The causal chain analysis method used in this article can generate testable predictions to improve welfare and achieve protection of common benefits.

2 The multidimensional mechanisms, evolutionary characteristics and contemporary ecological connections of animal domestication

2.1 Domestication pathway and selection pressures

Most accounts place the origin of dog and cat domestication on a commensal track rather than deliberate capture. early canids and felids lingered around human refuse and rodent-rich storage sites, where tolerance toward people was rewarded with easy calories. Over time, reduced fear and lower reactive aggression became the traits that paid off. This process

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is central to the "domestication syndrome," a suite of traits including altered coat color, floppy ears, shortened muzzles, and reduced brain size that recur across domesticated species [2]. A leading explanation is the neural crest hypothesis. Changes in the development of multipotent neural crest cells help generate the domestication trait cluster [2]. These cells contribute to the formation of adrenal tissue, which is involved in stress responses. They can also influence pigmentation and craniofacial morphology. Supporting evidence includes long-term silver fox experiment, in which foxes became calmer and exhibited new fur patterns and other morphological changes after decades of domestication selection[9]. This experiment clearly demonstrates that the choice of behavior can trigger changes in physical and physiological traits, and this "behavior trait linkage" domestication mechanism has also been reflected in the domestication process of dogs and cats.

For dogs, the process may have begun when grey-wolf ancestors stayed near hunter–gatherer camps. Wolves that tolerated human presence gained access to food scraps and survived more easily. Over generations, this passive selection gave way to active human influence, as people favored animals with traits such as cooperative hunting, guarding, or companionship. This two stage process, initial self-domestication and intentional breeding, produced the great diversity of dog breeds and their deep attunement to human society.

Cats followed a similar but later and less intensive path. Around ten millennia ago, the wildcat Felis silvestris lybica was attracted to farming settlements in the Near East, attracted by rodents infesting grain stores [1]. The main selection pressure was tolerance of human proximity. Unlike dogs, cats were not integrated into cooperative tasks but instead provided passive pest control. As a result, domestic cats retain more independence and solitary tendencies. Their domestication was largely self-driven, and genomic studies reveal selection on pathways linked to learning and reward, rather than cooperative communication [8].

2.2 Human-directed social cognition and communication

An outcome of domestication is the emergence of skills for navigating human social worlds. Dogs show sensitivity to human communicative cues, a trait likely shaped by direct selection. Studies demonstrate that even puppies with little human exposure outperform hand raised wolves in using cues such as locating hidden food by following pointing and gaze cues [3]. This suggests that the ability is not entirely learned but has a strong genetic basis refined over coevolution. Dogs also engage willingly in mutual gaze with humans, which fosters bonding and communication. When faced with unsolvable problems, they look alternately at the task and at the human partner, effectively seeking help. In contrast, wolves usually persist on their own, showing a clear difference in social problem-solving strategies [4].

Domestic cats respond to human signals as well, although their expression is typically subtler and more context-dependent. Experimental work indicates that pet cats exhibit secure and insecure owner–attachment patterns, comparable to those identified in human infants: secure individuals explore more in the owner's presence, show distress upon separation, and seek proximity at reunion [6]. Cats can also follow pointing, use gaze direction, and discriminate their own names from other words [7]. However, consistent with a more independent evolutionary trajectory, they seldom engage in overt help-seeking during difficult tasks. Notable interindividual variability is observed: enriched early socialization is associated with stronger and more flexible human-directed communication, whereas limited or stressful early histories are associated with diminished expression of these behaviors.

2.3 Mechanisms

The behavioural shifts in domesticated dogs and cats are supported by changes at both neuroendocrine and genetic levels. In dogs, the oxytocin system is a central regulator of their pro-social tendencies towards humans. Oxytocin, the "bonding hormone" plays a role in mammalian social behaviour. Variants of the oxytocin receptor gene (OXTR) are associated with differences in behaviours such as gazing at humans and seeking contact [5]. Dogs with certain alleles are more likely to approach and interact with friendly strangers. Comparable patterns are found in humans, where OXTR affects empathy and cooperation. This suggests a conserved mechanism that was shaped during domestication [10]. In addition, mutual gaze between dogs and owners increases oxytocin levels in both, reinforcing attachment through a feedback loop.

The domestic cat genome shows clear adaptations to human environments. Comparative studies show selection signals in regions tied to neural processes, especially memory, fear conditioning, and reward learning [8]. These changes likely reduced fear and promoted tolerance, which supported adaptation to a commensal lifestyle. Selection on reward pathways may have strengthened cats' motivation to stay near human settlements with reliable food supplies. This form of selection would have encouraged individuals that were more responsive to rewards and better able to take advantage of human-provided resources. In contrast, dogs appear to have undergone selection that acted more directly on traits related to cooperative communication and joint activity with humans. Genetic changes in cats, by comparison, point to a more indirect route toward sociality. Rather than shaping overtly cooperative behaviours, these changes seem to have focused on reducing fear, lowering defensive reactions, and strengthening the ability to learn from and adapt to the opportunities present in a human-dominated environment. The pattern indicates that different genetic routes can end in similar behavioural outcomes. The mechanisms are not the same in each species. Even so, both dogs and cats learned to live peaceably alongside people. Genes do not act in isolation. Early handling and routine exposure to humans pull on these tendencies. In practice, an animal's adult profile reflects that mix. Genetic background and developmental history combine to shape how well an individual adjusts to human settings.

2.4 Developmental timing and sensitive periods

Domestication seems to have shifted developmental schedules in ways that make human attachment easier to form. In dogs, the main socialisation window spans about weeks three to twelve. During this stage, puppies are unusually open to bonding and to sampling new stimuli. Varied contact with people, different voices and sounds, unfamiliar surfaces, and gentle handling leaves long term benefits. Missing that window often carries costs that persist into adulthood, including fear, high reactivity, and sometimes aggression.

Cats show a comparable window that begins earlier and ends sooner. It lasts from approximately the second to the seventh week of life. During this time, human touch has a strong and lasting impact on kittens. Kittens who are frequently handled during these weeks tend to be more confident and less stressed around people. Maternal character also shapes outcomes. Kittens from calmer mothers usually turn out friendlier, hinting that inherited traits combine with early social experience.

Together, the data point to small differences in a pet's early life can influence its adult behavior, and that environment can further amplify these effects. For example, Pets raised in homes usually see people every day. In shelters, social contact is irregular and less predictable. Shelters often face stress and crowding. Animals there rarely receive individual attention. Breeding practices add another layer. Responsible breeders usually give young animals varied contact, but this is not always the case in less careful settings. Cultural expectations also play a role: some regions view pets as family members, while others do not, leading to a reduction in daily human contact in some settings. In short: domestication is not a single genetic shift; it is a continuous interaction between predispositions and the environment that fosters their lives.

2.5 Contemporary ecologies

Many dogs and cats live as household companions, yet a substantial share of the global population remains free roaming or community managed. These animals offer a living laboratory for observing how evolutionary pressures play out in human dominated ecologies. Domestication did not end in prehistory. It continues on streets, in markets, and along peri urban edges where people and animals meet every day.

Free roaming dogs are notably adept at exploiting anthropogenic resources. Many form small, loosely organised groups and rely on human linked subsidies such as direct feeding or scavenging refuse. Survival depends on reading human intentions. Successful individuals and groups approach when the situation looks safe and worthwhile and withdraw when risk rises. Over time, local norms shape patterns of affiliative behavior.

Community cats show comparable flexibility. Colonies usually form around concentrated resources, such as areas where people provide consistent food. Within these groups, cats adjust their tolerance toward others and their responses to humans according to how predictable resources are. In stable colonies with regular feeding, aggression is reduced. In unstable settings, competition is higher. These patterns demonstrate how ecological pressures continue to shape behaviour in ways that resemble, but are not identical to, the original commensal domestication pathway.

Ecological and public-health consequences follow. Free-ranging cats can be substantial predators of small vertebrates in some regions; free-ranging dogs may compete with wild carnivores or function as reservoirs for pathogens of concern to humans and wildlife alike. Consequently, the behavior of community populations has implications for conservation biology, epidemiology, and urban management. Understanding how domestication interacts with present-day ecological pressures is therefore essential for both animal welfare and human well-being [11].

2.6 Synthesis: convergence and divergence

Symbiotic domestication led dogs and cats to develop overlapping traits. Both species are more sensitive to human cues and capable of forming attachment bonds, enabling them to successfully coexist with humans. They also show notable flexibility. This helps them survive in cities, where working with or simply tolerating humans often secures food and shelter.

However, the details of their histories diverge in important respects. In many settings, dogs worked with humans in cooperative tasks, from hunting and guarding to serving as companions. Living with humans over many generations encouraged dogs' willingness to seek help, sustained communication, and a drive for social cooperation. Cats took a different path. They can form strong bonds with their owners, but when tasks become difficult, they often solve problems independently.

The social structures of the two species also differ. Free-ranging dogs typically gather in small groups, some of which involve cooperation and even division of labor. Cats rarely exhibit this pattern. Cats are inherently more solitary and typically form groups only where food is plentiful. These differences can be traced back to their wild ancestors. Wolves rely on group cooperation, while wild cats mostly hunt alone. In human environments, these tendencies translate into complementary roles. Dogs typically play companion roles, participating in hunting or guarding. Cats, by contrast, have adapted more flexibly within human households, mostly as mutually tolerant cohabitants.

In short, these histories suggest that domestication often led to shared traits in attachment and cue sensitivity, but differences in cooperation and social motivation were largely preserved. They also point to a wider implication. What people do each day shapes animals in ways that go well beyond simple accommodation. Everyday life continually shapes the behavior and life histories of animals.

3 Conclusion

The balance of evidence indicates that commensal domestication fostered similar capacities for attachment and for sensitivity to human cues in both dogs and cats. At the same time, historical context and local ecology seem to have preserved differences in cooperation, help seeking, and social organisation. First, dogs show strong human oriented social cognition. They use pointing and gaze, they seek help proactively, and mutual gaze strengthens bonds. This ability is supported by oxytocin-related mechanisms and is enhanced through early socialization. Cats also form stable attachment bonds and interpret human cues (pointing, gazing, name), but they more often solve problems independently and regulate their interactions with humans based on context and prior experience. Second, mechanistic evidence suggests that canine social motivation is closely linked to neuroendocrine pathways that promote interspecies cooperation, while feline genomic signals emphasize learning, reward, and fear attenuation—an indirect pathway to tolerance and closeness. Third, developmental timelines differ. Dogs have a longer socialization window, while cats have an earlier and shorter period, which makes early handling essential. Contemporary ecologies also play a role. Free-roaming and community populations continue to shape behaviour through access to resources, human attitudes, and local risks. These factors have consequences for conservation and public health. Implications. An integrated selection-to-ecology framework helps explain why dogs and cats show similar human-oriented behaviours through different routes, and how policies can respect species-specific motivations. This perspective can inform welfare and urban management. For example, socialization programs can be timed to match each species' sensitive period. Community-animal programs can reduce fear and encourage predictable, low-risk interactions. Public health strategies can also target areas with frequent human–animal contact. Limitations and future directions. Current evidence is uneven across cultures, and causal links between genes and behaviour are rare. Methods for measuring behaviour also differ, and few longitudinal, preregistered studies exist. Future research should (i) standardize behavioural tests across environments, (ii) connect genomic, hormonal, and behavioural data in multi-site studies, (iii) measure gene × environment effects under different housing conditions, and (iv) evaluate management and policy interventions as natural experiments. These steps will refine predictions from the proposed framework and support better outcomes for humans, animals, and ecosystems.

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