

# Emotions and Intelligence of Urban Birds

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## Abstract

With the accelerating pace of global urbanization, urban birds have become a focal point in behavioral ecology and cognitive science, demonstrating remarkable cognitive behaviors and rich emotional expressions as they adapt to complex anthropogenic environments. This paper reviews research progress on urban birds across two dimensions: intelligence and emotion. Regarding intelligence, urban birds exhibit exceptional tool manufacture and use, multi-step problem-solving and logical reasoning, as well as robust spatial memory and social learning capabilities; these adaptive behaviors are key to their successful establishment in urban ecosystems. In terms of emotion, studies indicate that birds possess not only basic emotions such as joy, fear, and sorrow, but also potentially empathic capabilities. Their complex vocal communication systems further reflect a high degree of sociality. The article further explores the roots of the evolution of intelligence and emotional capacities in urban birds from three perspectives: evolutionary pressures, social learning, and brain structure. Understanding the emotions and intelligence of urban birds is significant for promoting urban biodiversity conservation and achieving harmonious coexistence between humans and nature.

## Keywords

Urban Birds, Cognitive Behavior, Emotional Expression, Tool Use, Social Learning, Environmental Adaptation

## 1. Introduction

Amidst the high-rises, urban parks, and even bustling streets, birds, with their diverse forms and behaviors, constitute an indispensable part of the urban ecosystem. They are not only indicator species for environmental health, but also serve as a vital link connecting urban residents with nature. As urbanization accelerates, birds face multiple challenges, including habitat fragmentation, changes in food resources, and anthropogenic disturbance. Remarkably, however, many bird species have not only

adapted to the urban environment, but also display astonishing intelligence and rich emotional expressions.

In recent years, a growing body of research indicates that urban birds exhibit high complexity in behavioral adaptability, social structure, cognitive ability, and even emotional expression. From crows using tools to obtain food, to magpies displaying empathetic behaviors towards conspecifics, from sparrows learning to utilize resources provided by humans, to birds communicating through complex song systems—these phenomena suggest that urban birds are not merely “surviving”, but are “living” in a highly intelligent and emotionally rich manner.

## 2. Intelligence: The Survival Toolkit of Urban Birds

### 2.1. Tool Manufacture and Use

The capabilities urban birds demonstrate in tool use are astounding, particularly among corvids (such as crows and magpies). Studies show that urban crows can not only use natural materials but also innovatively employ various human-made items. In Sendai, Japan, crows learned to place nuts on roadways, using passing vehicles to crack the shells, and retrieve the meat safely when traffic lights turn red. This complex behavioral sequence requires the integration of multiple cognitive abilities such as tool use, temporal judgment, and risk assessment, reflecting the high intelligence of birds in solving practical problems. New Caledonian crows (*Corvus moneduloides*) manufacture hook-like tools in the wild to extract insects from tree holes; in urban environments, this ability is further extended and enhanced. They can identify and select suitable artificial materials (e.g., wire, plastic pieces) as tools, even modifying these materials to improve efficiency. Research finds that these birds can flexibly apply existing tool-use experience when faced with novel problems, demonstrating significant cognitive flexibility [1].

More surprisingly, urban birds also show signs of tool culture. In non-human contexts, “culture” can be defined as a system of behavioral patterns, skills, or knowledge acquired through social learning and transmitted across generations, characterized by within-group sharing and between-group differentiation [2]. For example, different crow populations in different regions may develop distinct tool-use traditions, and these cultural differences are transmitted and maintained within groups through social learning.

### 2.2. Problem-Solving and Logical Reasoning

The urban environment provides abundant opportunities for problem-solving, driving the development of birds’ cognitive abilities. Experimental studies show that pigeons (*Columba livia*) can not only learn to discriminate between different visual patterns but also understand abstract conceptual relationships. In a carefully designed experiment, pigeons trained to recognize images containing specific numerical features demonstrated an ability for basic numerical comparison and judgment, showing surprising numerical competence. Urban crows excel particularly in solving multi-step tasks. Researchers designed a complex eight-step sequential

task requiring crows to perform multiple actions (pulling strings, moving stones, using sticks) in order to receive a food reward. Impressively, some individuals could complete the entire sequence through observation and reasoning without incremental training [3]. This sequential operation ability indicates that birds possess not only motor memory but can also mentally simulate the outcomes of actions, engaging in mental simulation and planning.

Individual differences in problem-solving ability are also noteworthy. Research finds significant individual variation among urban birds in innovatively solving problems, correlated with factors such as age, sex, and social status. Older individuals often solve problems more effectively based on experience, while younger individuals show greater explorative and innovative tendencies. This individual variation provides the raw material for the evolution of cognitive abilities, enabling bird populations to employ multiple strategies to cope with environmental challenges.

### 2.3. Memory and Learning

The urban environment demands excellent learning and memory capabilities from birds, a pressure that has driven the rapid development of their cognitive systems. Studies show that urban birds exhibit impressive spatial memory, capable of precisely remembering the location of numerous resource points. Clark's nutcrackers (*Nucifraga columbiana*) can remember the locations of thousands of cache sites for several months, a spatial memory ability that even surpasses that of most mammals. In urban environments, this ability extends further to memorizing patterns of human activity and the locations of artificial structures.

Social learning plays a key role in the adaptation process of urban birds. Juveniles learn crucial skills such as predator recognition, food selection, and tool use by observing the behavior of parents or other adults. This cultural transmission mechanism significantly accelerates the adaptation of birds to urban environments. The behavior of British blue tits (*Cyanistes caeruleus*) learning to peck open milk bottle tops to obtain cream spread across the country through social learning within just a few decades [4]. This rapid cultural transmission demonstrates the powerful role of social learning in adapting to novel environments.

Urban birds also exhibit remarkable adaptive learning abilities. Faced with constantly changing patterns of human activity, they can quickly adjust their behavioral strategies. Some urban pigeons have learned to adjust their foraging times and locations based on differences in human activity between weekdays and weekends; this temporal learning ability indicates they possess relatively complex time cognition mechanisms. More surprisingly, these birds can also recognize and remember the characteristics of specific individuals, such as the faces or clothing features of people who regularly provide food.

The neural basis of learning ability is also crucial. Research indicates that urban birds frequently engaged in cognitive activities exhibit adaptive changes in brain structure, particularly in regions associated with learning and memory, such as the

hippocampus. These neurological changes provide a biological foundation for the birds' exceptional learning capabilities and reflect the shaping influence of the urban environment on their cognitive systems.

### **3. Emotion: They Are Not Just Surviving, But Living**

#### **3.1. Emotion and Empathy: The Avian Spectrum of Feelings**

The view that birds possess rich emotional lives is supported by increasing scientific evidence. Neurobiological studies show that avian brains have neural substrates for emotion processing analogous to those in mammals, including homologous structures to the amygdala and dopamine reward systems. Urban birds often show significant behavioral and physiological changes in situations such as loss of a mate, death of offspring, or territory intrusion.

Magpies (*Pica pica*) exhibit behavior resembling a “funeral” when a conspecific dies: multiple individuals gather around the deceased, emit specific calls, and sometimes cover the body with grass or twigs. This ritualized behavior lasts for several minutes before the group gradually disperses. Researchers suggest this may be an expression of empathic capabilities in birds, reflecting their cognitive and emotional response to the death of a group member [5].

Birds in urban environments also demonstrate clear stress-coping strategies. Research indicates that urban sparrows adjust corticosterone levels to maintain physiological balance when facing chronic stress. Individuals capable of effectively regulating stress responses show higher breeding success and survival rates. This emotional regulation ability is a crucial factor in the successful adaptation of urban birds.

#### **3.2. Sociality and Communication: The Complex World of “Bird Song”**

Urban birds live in highly complex social networks, making their communication systems exceptionally sophisticated and flexible. Bird vocalizations are used not only for territory demarcation and mate attraction but also carry rich social information. Studies show that some songbirds can identify individual identity, emotional state, and even behavioral intent through calls.

Urban noise pollution poses a severe challenge to avian communication but has also driven the evolution of acoustic adaptations. Many urban birds have developed coping strategies, including adjusting call frequency (raising pitch to avoid low-frequency urban noise), altering calling timing (vocalizing during traffic lulls), or increasing repetition rate to improve message transmission success. These adaptive changes have even become genetically fixed in some populations, illustrating the rapidity of vocal evolution in urban settings.

More surprisingly, some urban birds show dialect variations. Conspecifics in different cities may develop different “dialects”; this cultural differentiation has been documented in crows, sparrows, and some songbirds. For instance, urban sparrow songs are typically higher-pitched and faster-paced compared to their rural coun-

terparts, differences believed to be adaptive adjustments to the urban acoustic environment.

## **4. Unraveling the Roots: Why Are Urban Birds So Intelligent?**

### **4.1. Evolutionary Pressures**

The urban environment poses unique and intense selective pressures on birds, driving the rapid development of cognitive abilities. Compared to traditional natural environments, urban settings are characterized by higher unpredictability, novelty, and complexity, traits that positively select for individuals with enhanced cognitive capabilities. Studies show that urban birds perform significantly better than their rural counterparts in tests of innovative problem-solving, response to novel objects, and human avoidance distance, reflecting differential selection pressures under varying environmental conditions.

Urban selection operates in multiple ways. Firstly, the distribution and availability of food resources have changed dramatically, requiring birds to develop new foraging strategies and food handling techniques. Individuals capable of innovatively utilizing human food resources or developing new feeding methods gain a clear adaptive advantage. Secondly, predation pressure in cities has changed; the emergence of novel predators (e.g., domestic cats, vehicles) requires birds to develop appropriate recognition and escape strategies. Furthermore, the complex spatial structure of the urban environment selects for individuals with superior spatial memory and navigation skills.

Notably, significant differences exist in the adaptive capacity of different species to urban environments. Some species (e.g., crows, sparrows, pigeons) exhibit exceptional urban adaptation capabilities, while others struggle to survive in cities. This difference largely reflects the baseline level and developmental potential of cognitive abilities across species. Species with inherently stronger learning abilities and behavioral flexibility are more likely to adapt to the challenges of the urban environment through behavioral plasticity and genetic evolution.

### **4.2. Social Learning**

Urban birds often live in high-density groups, providing ideal conditions for social learning. Social learning not only accelerates the transmission of adaptive behaviors but also allows cultural traditions to form and persist. Individuals rapidly acquire skills suited to the urban environment through observation, imitation, and even active teaching behaviors. This non-genetic information transmission mechanism greatly enhances adaptation efficiency, allowing beneficial innovations to spread quickly within groups.

Social learning in urban environments exhibits several notable characteristics. Firstly, the content of learning is more diverse, including observational learning of human behavior, techniques for utilizing artificial structures, and identification of novel dangers. Secondly, the speed of learning is faster; some adaptive behaviors can become widespread within groups in just a few years or even months. Addition-

ally, the structure of social networks influences the efficiency and reach of information transmission, with the behaviors of central individuals often being learned and imitated more quickly by others.

The formation and maintenance of cultural traditions are important outcomes of social learning. Distinct behavioral traditions, such as specific tool-use methods, foraging techniques, or song dialects, can be observed in some urban bird groups. These traditions not only reflect the historical experience of the group but also form part of the group's cultural identity. Interestingly, different groups may develop different traditions to solve similar problems; this cultural diversity provides valuable natural experiments for studying behavioral evolution.

### 4.3. Brain Structure

Although the avian brain is structurally distinct from that of mammals, it exhibits remarkable functional convergent evolution. Specifically, the nidopallium region in the forebrain plays a role in cognitive processing analogous to the mammalian prefrontal cortex. Research indicates that in birds frequently engaged in complex cognitive tasks, the structure and function of these regions undergo significant adaptive changes.

The brains of urban birds exhibit several noteworthy characteristics. Firstly, brain regions associated with cognitive functions are relatively well-developed, particularly those processing spatial information, social information, and executive functions. This structural divergence stems partly from experience-dependent shaping during development and partly reflects the outcomes of genetic evolution. Secondly, neuronal connectivity patterns have undergone adaptive changes, enabling more efficient and flexible information processing. Furthermore, adjustments have occurred in neurochemical systems, such as the functional optimization of neurotransmitter systems, including dopamine and serotonin, which support more complex cognitive and emotional processing.

Brain plasticity serves as a critical foundation for the adaptive capacity of urban birds. Studies show that enriched environments and cognitive challenges can promote neurogenesis (the formation of new neurons), synaptogenesis (the establishment of new connections), and gliogenesis (the proliferation of glial cells). These mechanisms of neural plasticity enable birds to adjust brain function according to environmental demands and optimize cognitive performance. The persistent cognitive challenges provided by the urban environment likely promote avian brain development precisely through these mechanisms.

Comparative neuroanatomical studies reveal adaptive differences in brain structure across species. Those species that have successfully adapted to urban environments typically possess relatively larger brain sizes and highly developed associative processing regions. These structural features provide the physical substrate for complex cognitive abilities, enabling these species to effectively process complex information and social interactions within the urban environment. Notably, the evolution of brain structure may follow modular principles, with different cog-

nitive functions corresponding to the development of specific brain regions; this specialization allows birds to achieve efficient cognitive processing within a limited cranial capacity.

## 5. Conclusions

Urban birds play important roles in ecosystems and are also bearers of intelligence and emotion. Through tool use, problem-solving, social learning, and emotional expression, they demonstrate astonishing behavioral complexity. These abilities are not only manifestations of biological adaptation, but also provide a valuable window for understanding the evolution of animal cognition and emotion.

The emotions and intelligence of urban birds remind us that they are not merely “inhabitants” of the city but sentient beings with rich inner worlds. In the process of advancing urban ecological development, we should pay greater attention to the welfare of these feathered neighbors, making cities truly shared homes for both humans and birds.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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