During the Nestling Period, Testosterone and Heterospecific Aggression were Observed In Adult Eastern Bluebirds (*Sialia sialis*)

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Received 05 Sep 2021; **Accepted** 28 Sep 2021; **Published** 28 Nov 2021

Abstract

Conspecific competition is thought to have a stronger selection effect on aggressive behaviour and its underlying physiology in birds than the heterospecific competition. We hypothesised that the hormone-behaviour interaction between testosterone and aggression could be influenced by severe heterospecific competition among secondary cavity nesters. Adult Eastern Bluebirds (n=34) were subjected to three challenge conditions that simulated territorial intrusions (STI) by heterospecific (House Sparrow) and conspecific (Bluebird) using live and stuffed decoys and their respective playback vocalisations. Late in the nesting cycle, Eastern Bluebirds responded to simulated territorial intrusions (STIs) by Conspecific and heterospecific. When compared to homospecific STI, the aggressive response elicited by a heterospecific STI was muted. Individuals with high aggression levels had slightly higher mean testosterone concentrations than those with low aggression levels. For all STI conditions, baseline T and aggression were positively correlated, but the relationship was strongest for the live heterospecific decoy. Furthermore, the live heterospecific decoy elicited a stronger aggressive response than the stuffed decoy, implying that other cues produced by the living bird, in addition to auditory and visual cues, influenced individual responses to a challenger. Because of the increased frequency of human-wildlife interactions, it is becoming increasingly important to understand how anthropogenic disturbance affects animal populations.

Keywords: Androgen corticosterone • Ornament plumage • Structural colour

Introduction

Several recent studies on birds have revealed that individuals living in high-disturbance areas are frequently more aggressive than conspecifics living in less-disturbance areas. The purpose of this study was to see if heterospecific aggression varied in Western Bluebirds (*Sialia mexicana*) breeding in artificial nest boxes in the Okanagan Valley of British Columbia, Canada, across a gradient of human disturbance. Unlike most previous studies, which focused on the effects of high disturbance (urbanisation), our study concentrated on sites with lower levels of human disturbance, such as ranch lands, vineyards, and recreational trails.

this response varied with the level of human disturbance experienced by the pair, as well as whether aggression was related to female flight initiation distance (FID; a measure of boldness), the local density of boxes in a territory, and the presence of neighbouring cavity-nesters. Overall, aggression was significantly higher toward the competitor stimulus (wren) than toward the non-competitor stimulus (goldfinch). Aggression toward the wren model did not vary with disturbance level; however, aggression toward the goldfinch model increased significantly in more disturbed areas. Female FID did not differ across disturbance categories, but it was correlated with aggression toward the wren, with individuals who responded more aggressively having marginally larger FIDs. Female FID was not related to aggression toward the goldfinch [1].

A variety of non-exclusive signalling functions have been proposed for elaborate and costly sexual ornaments. Indicator models of sexual selection propose that elaborate ornaments evolve to accurately signal a person's phenotypic or genetic quality. Because only high-quality individuals achieve full ornament expression, the ornaments are trustworthy signals.

Quality has been defined in a variety of ways, including genetic quality, parental quality, physiological condition and resistance to stressors, parasite resistance or health, and competitive ability. These signalling functions have been supported by research on the signalling value of elaborate bird plumage colouration.

Over the last 50 years, the global human population has more than doubled; it now grows at a rate of about 80 million people per year. One result of this expansion is an increase in the frequency of interactions between humans and wildlife. Human disturbance, according to studies, may increase the number of stressful encounters for bird populations, resulting in a decline in fitness. Birds have two options for reducing these negative effects: they can change their behaviour to avoid encounters with humans or they can develop an improved tolerance of human disturbance.

Hormones play an important role in regulating behaviour and fitness. Experimenting with hormone levels has taught us a lot about the direct effects of hormones on behaviour and reproductive success. In addition to these studies, we need to assess natural individual variation in hormones over time about behaviour and fitness, as this practice can help us understand how hormonal profiles evolve. Testosterone has been linked to fitness-related traits and is expected to interact with important behaviours like parental care. The level of parental care provided to children is critical in shaping the environment in which they grow.

Both males and females may benefit from mutual mate selection in socially monogamous species with biparental care . If an ornament indicates an individual's potential parental quality, as suggested by the Good Parent Hypothesis, mate choice based on this ornament should be favoured in these species, as the mate and offspring would benefit directly . The evidence for the Good Parent Hypothesis signalling function of plumage ornamentation is mixed. A few studies have found evidence for a link between male plumage colour and nestling provisioning.

More ornamented males provide more nestling care, according to other studies. In bluethroats (*Luscinia svecica*), yellowhammers, or mountain bluebirds (*Sialia currucoides*), male colouration has not been found to signal parental care. A negative relationship between male plumage colour and parental care investment has been discovered in several studies [2].

There is substantial evidence that birds in highly disturbed areas, such as cities, are more tolerant of humans than their conspecific counterparts in less disturbed areas. Reduced flight initiation distances (FID; the distance at which a bird retreats when approached by a potential predator) in urban versus rural populations have been documented in a growing number of studies. Such decreases in FID (commonly referred to as an increase in boldness) have been attributed to learning or microevolutionary processes and may be a result of selection for other behavioural traits that aid in coping with disturbance.

A few studies have also looked into the possibility of female plumage colour indicating maternal care. Female underwing colour, as well as the size and darkness of the face mask, are related to maternal investment in Northern cardinals (Cardinalis cardinalis), female rump colour is also related to provisioning behaviour. However, studies of bluethroats, European starlings (Sturnus vulgaris), and Western bluebirds (*Sialia mexicana*) found no link between female plumage colour and maternal care.

In a similar vein, recent studies on aggression have revealed that birds

in more disturbed environments may exhibit higher levels of territorial and defensive behaviour. Song Sparrows (Melospiza melodia) in towns and on university campuses, for example, are more aggressive than conspecifics in rural habitats. Similar patterns have been observed in a variety of other bird species. Other than provisioning effort, plumage colouration may indicate other components of parental behaviour, such as nest defence behaviour. Melanin plumage signals, in particular, have been shown to reflect nest defence.

The advantages of increased aggression in coping with disturbance are not well understood; however, a positive relationship between aggression and anthropogenic disturbance could emerge in a variety of ways. Aggressive behaviour may be advantageous if it facilitates the acquisition of high-quality territories and limited resources, or if it protects reproductive investment. At the same time, highly aggressive people may incur several costs, including the expression of aggression in inappropriate contexts, decreased energy or time available for other behaviours, such as reproductive efforts, and an increased risk of injury and death.

Thus, while the costs and benefits of aggression vary depending on the context, aggression can lead to a selective advantage in some cases. For example, competition for territories in higher quality urban and suburban habitats may increase aggression in cases where rural habitats provide poorer breeding environments (due to more natural predators, fewer protected nesting sites, or even higher human persecution). Increases in human disturbance may also be associated with increased breeding population density, which may elicit greater aggression.

At a proximate level, plumage colouration may reflect nutritional condition and provide a signal of foraging ability and/or resistance to nutritional stressors. Plumage colouration is primarily derived either from feather microstructure or by pigments such as carotenoids or melanins. Condition dependence of plumage colouration has been most clearly supported for carotenoid-based colouration because the deposition of carotenoid pigments is dependent upon dietary access. Similarly, the synthesis of melanin pigments is dependent on the ingestion of amino acid precursors. Thus, limited intake of these amino acid precursors through dietary restriction might constrain the expression of melanin colouration [3].

Because of flaws in the precision of the formation of feather nanostructures, the nutritional condition has been hypothesised to affect the structural condition.

There is some support for this hypothesis for both iridescent and non-iridescent structural colouration. Hormones play an important role in the regulation of behavioural and reproductive characteristics. Many studies on the relationships between hormones, behaviour, and fitness have used "phenotypic engineering" to manipulate hormone levels artificially and then study the effects on traits of interest. Males with artificially increased testosterone levels, for example, have been shown to exhibit more mate-attracting behaviour, engage in more extra-pair copulations, defend larger territories, compete with other males, and contribute less to young care.

Circulating testosterone levels rise above baseline in response to mate and territory competition, according to the challenge hypothesis. A surge in testosterone in response to social challenges strengthens subsequent sexual displays and prolongs aggressive behaviours. The focus of the challenge hypothesis tests is on the behavioural and physiological responses to conspecific intrusion. because conspecific competition is thought to be more powerful than heterospecific competition as a selective factor This assumption is being looked into and should be tested. We investigated whether testosterone and aggression levels were related to interspecific competition.

The relationship between baseline circulating testosterone levels and aggressive behaviour expression in adult eastern bluebirds in response to various competitor challenges during the late nesting period *Sialia sialis*, the Eastern Bluebird, is an obligate secondary cavity nester that competes with other cavity-nesting species. In this study, we addressed two issues. To begin, do Eastern Bluebirds respond to simulated territorial intrusions (STIs) by conspecifics and heterospecifics late in the nesting cycle? Even after establishing territories, they are vulnerable to House Sparrow and male bluebird invasions. Conspecifics through cuckoldry14 and sparrows through direct mortality to nestlings can both jeopardise an individual's reproductive success [4].

Discussion

Is it possible for bluebirds to respond to territorial intrusions late in the nesting cycle? Even after territories are established, Eastern bluebirds compete fiercely for limited cavity space with other cavity nesters. Based on the challenge hypothesis, we predicted that Eastern Bluebird aggression would persist late in the nesting cycle due to their vulnerability to intrusions by both conspecifics and heterospecifics. STIs from conspecifics and heterospecifics elicited aggressive responses from males and females in this study, indicating that conspecific and heterospecific intruders pose a threat to eastern bluebirds.

Males responded less to the heterospecific decoy than to the conspecific decoy. Perhaps the risk of nest failure due to House Sparrow cavity usurpation is less than the risk of losing paternity to a conspecific male. In the Midwestern United States, Eastern Bluebirds attempt second broods,26 so males may still need to guard against sexual competitors late in the nesting cycle of first broods. To determine whether Eastern Bluebirds respond to risk probabilities, we propose examining aggressive responses under conditions of different conspecific and heterospecific density, as well as intruders with varying risks.

For example, compare the aggressive behaviour of Eastern Bluebirds to that of Black-capped Chickadees, which pose little risk of nest box usurpation, to that of House Wrens (Troglodytes troglodytes), which frequently destroy Eastern Bluebird nests. Lehtonen showed that cichlid fish modulated their aggressive responses based on the risk posed by a heterospecific intruder (breeding or non-breeding colours).

Eastern Bluebird aggression is measured using three different metrics: direct attacks, hovering, and flyovers. Females were less likely to attack and more likely to fly over conspecific decoys than males. The different responses could be explained by the different reproductive strategies of each sex. During a given breeding season, Eastern Bluebirds are known to double brood and occasionally change mates. 27 Male Eastern Bluebirds mate-guard and drive away sexual competitors, which explains the attack behaviour observed in this study. Female flyover behaviour could be interpreted as her evaluation of a potential new sexual partner [5].

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Cite this article: Stewart J. During the Nestling Period, Testosterone and Heterospecific Aggression were Observed In Adult Eastern Bluebirds (Sialia sialis). J Steroids Horm Sci. 2021, 12 (5), 001-002.