

Behavior of domestic chickens – insights from a narrative review

Comportamento de galinhas domésticas – percepções de uma revisão narrativa

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Submission: 12/01/2022 | Acceptance: 16/06/2022

ABSTRACT

The intensification of poultry production systems has brought major changes in domestic fowls' physical and social environment. The management of these birds has received considerable attention in recent years due to new demands from consumers, especially those related to welfare. Behavior is the way that animals respond to the different stimuli they encounter in their environment. The behavioral expressions of poultry and the application of this knowledge in the care of the stock plays an important part in the maximization of the production efficiency of the poultry chain. Thus, defining ethical limits and guidelines for poultry production is essential to promote the development of new production practices, and by that ensure quality and productivity without putting bird welfare at risk. This review is based on scientific literature and highlights the main behavioral expressions of domestic chickens, including social, feeding, and reproductive expressions, in addition to stereotypes and strategies for social adaptation. Thus, it will promote to the reader and for the scientific community a better understanding about subjects that are not frequently discussed and by that help behavioral analyzes.

KEYWORDS: animal welfare; broiler; hen.

RESUMO

A intensificação do sistema de produção avícola trouxe profundas mudanças no ambiente físico e social das aves domésticas. O manejo dessas aves tem recebido considerável atenção nos últimos anos devido às novas demandas por parte dos consumidores, principalmente aquelas relacionadas ao bem-estar. O comportamento é a maneira como os animais respondem aos diferentes estímulos que encontram em seu ambiente. As expressões comportamentais das aves domésticas e a aplicação desse conhecimento no cuidado dos animais desempenha um papel importante na maximização da eficiência de produção da cadeia avícola. Assim, definir limites éticos e diretrizes para a produção avícola é fundamental para fomentar o desenvolvimento de novas práticas produtivas, e assim garantir qualidade e produtividade sem colocar em risco o bem-estar dos animais. Esta revisão destacará as principais expressões comportamentais das aves domésticas, dentre elas as expressões sociais, alimentares, reprodutivas, além de estereotípias, e identificará as estratégias de adaptação social. Assim, promoverá ao leitor e a comunidade científica uma melhor compreensão de assuntos pouco discutidos para assim auxiliar em análises comportamentais.

PALAVRAS-CHAVE: bem-estar animal; frango de corte; poedeiras.

INTRODUCTION

Chicken domestication started with red junglefowl (*Gallus gallus*; ALBINO & TAVERNARI 2010) and is native to multiple regions in Southeast Asia (HATA et al. 2021). These birds were first used as fighting animals or in rituals. Then, breeding the species began to be treated as an economical activity to generate profit from the production of meat and eggs (NÚÑEZ-LEON et al. 2019, RUBIN et al. 2010).

During this period, animal welfare science's focus was to attend to animals' basic needs, such as biological function. However, over the years, scientific evidence has revealed animal suffering in the face of behavioral needs, so emotions and feelings began to be considered (DAWKINS 1977, 1978). Such factors demonstrate the sentience of animals, which means that animals have the ability to feel painful sensations and feelings (ABREU; MAZUCO; SILVA, 2017). As a result, avoiding suffering and providing animal's

preferences became to be considered essential for adequate animal welfare (DAWKINS 1988).

Thereby, ethology can be used as a tool that can help us to understand animal's health and their requirements (WEMELSFELDER & MULLAN 2014). Behavior can be analyzed by the movements of a particular individual or group and is highly influenced by the environment in which this bird is conditioned (free, semi-confinement, or total confinement; AMARAL et al. 2016, COSTA et al. 2012).

Thus, in this literature review, we will discuss poultry's main behavioral expressions, social, feeding, reproductive expressions, and stereotypes, and identify the strategies of social adaptation in such conditions.

Behavior of domestic chickens

Communication

Communication involves the transfer of information from one individual to another. The study of animal communication encompasses the functionality, structure, use, and complexity characterization (MARINO 2017). The animals are non-linguistically communicators, but they communicate through voluntary affective manifestations, and these are cognitively complex (SLOBODCHIKOFF 2012).

Chicken communication consists of at least 30 distinct vocalizations, which some can be identified as alarm, warning, mating, fear, distress, food, contact, territorial, dust bathing, perching, battle cries, privacy, time calls, laying, nesting, mating, threat, submissive and dominance (TEFERA 2012). Referential communication involves signals such as calls and showing off that convey information about specific elements of the environment, which makes this communication complex because the animals assign meanings to each signaling, unlike humans, who use words and objects. Referential communication is observed in both mammals and birds (MARINO 2017).

Studies also suggest that chickens are sensitive to auditory effects and the auditory system begins to develop during incubation (TONG et al. 2013), and they are also capable of perceiving and processing different frequencies, but this could change among the altricial species (RIVERA et al. 2018). Chickens demonstrate considerable complexity. A rooster, for example, emits distinct alarm calls when a predator appears. When they see an aerial predator the sound is different from a terrestrial predator. Also, strong alarm calls were made when a large fast-moving hawk appears (MARINO 2017). Such factors suggest that chicken communication is voluntary and shaped by their cognition and social awareness.

The use of visual recognition is also very important for chickens. Birds recognize another through plumage (LOVETTE & FITZPATRICK 2016) and dominant or submissive posture (BHANJA & BHADAURIA 2018). For these reasons, birds can discriminate against individuals to build the basis of social and hierarchical relationships, even with unfamiliar individuals. Birds can recognize who are or aren't a member of their social group, and they can also distinguish members inside their group. Under experimental conditions, chickens have demonstrated the ability to recognize large numbers of individuals of the same species (MARINO 2017).

Therefore, we observe that poultry birds have a complex mean of communication, which affect their behavior and subsequently their production. Through the understanding of behaviors, it is possible to change the welfare of birds in a positive way and guarantee good zootechnical indices.

Perspective and social manipulation

The ability to take another individual's perspective is a complex cognitive ability that allows an individual to not only respond to their co-species but also to be able to manipulate them (MARINO 2017). This ability is related to "Machiavellian intelligence," defined as a kind of a ploy that involves misleading and manipulation (BERECZKEI 2017).

Deception is an example of Machiavellian intelligence in chickens. Males sometimes perform the food calling to attract the females even in the food absence as a trick (GYGER & MARLER 1988). However, females have also developed counter-strategies, and eventually, they stop answering the males that make the false alarm too often (EVANS 2002).

Social learning

Social learning is how social species take advantage of them by observing the behavior of their co-specifics and their consequences. Social learning appears to be a form of imitation (learning by action) or emulation (learning results), serving as a mechanism for transmitting learned behaviors over time (ZENTALL 2012).

Chickens develop social learning to avoid learning costs. Imprinting is a phenomenon in which animals memorize the properties of objects. First, they see it and then they chose or not a preference. This differs from general learning because has a higher learning efficiency and robust retention. It's mostly observed in chicks (NAKAMORI et al. 2013). Social learning can also explain why poultry synchronizes their behavior so much.

Social synchronization and facilitation

Social facilitation occurs when an animal's behavior increases with the same occurrence in its social partners. Birds' social facilitation of foraging behavior has been documented (OGURA et al. 2015). Synchronization, on the other hand, does not increase in the presence of other birds, but the animals' behavior is synchronized and happens at the same time, this allelomimetic behaviour are aspects of social and anti-predator strategies (EKLUND & JENSEN 2011)

EKLUND & JENSEN (2011) observed that White Leghorns chickens show less synchronized behavior than the red jungle fowl since those perched significantly more and at the same time. This shows that domestication has been able to change animals' behaviors. Other studies show that dominant birds and their subordinates showed a high level of synchronization in the locomotor pattern. These findings suggest that dominance can potentially modulate behavioral dynamics through the synchronization of locomotor activities (ALCALA et al. 2019).

Otherwise, feather cleaning occurs through social facilitation and synchronization (NICOL 1989). A study showed that laying hens housed by pairs in battery cages with visual access to other birds synchronized their feather cleaning (WEBSTER & HURNIK 1994). And also demonstrated that the density of cages increased in the same proportion of feather cleaning (PALESTIS & BURGER 1998).

In another study, laying hens showed a significant increase in agitation and body grooming behavior when they were in visual contact with a test bird (unfamiliar to the group) that were close to their housemates when compared to birds that had visual contact at a long-distance or no visual contact with the test bird (NICOL 1989). This behavior suggests that there is protection facilitation against predators because the birds close their eyes while cleaning their feathers and when they are in groups, the chance of any of the chicks to have their eyes open is bigger, resulting in better protection.

Empathy

Empathy has no consensus of definition but has been described as having a similar emotional aspect to another individual as a result of the perception of the other's difficult situation (DOHRENWEND 2018). Emotions, known as emotional contagion, tend to drive more than one individual in the social group, and are observed in farm animals (DÜPJAN et al. 2020).

EDGAR et al. (2011) conducted a study on how chickens respond to the suffering of their chicks and found strong evidence of empathy. The birds were subjected to three conditions: a control group, where hen and chicks had no disturbance; a group that received a mildly aversive puff of air in the cage where the chicks and hen resided; and a control group with noise. The hens showed no physiological or behavioral response to the air blowing into their cage, however, when they observed their chicks receiving the air blowing, there were behavioral and physiological changes in the hens that indicated emotional distress.

Hierarchy

Chickens tend to be sociable animals that form groups or flocks. When space is available, birds often form subgroups, each with an established social order (BHANJA & BHADOURIA 2018). Dominance is agonistic interaction between two individuals, in which one dominant individual subdues the other individual (CHASE & SEITZ 2011). Agonistic behavior in chickens includes fighting and pecking, as well as submissive responses such as avoiding contact (IFFLAND et al. 2021, TEUNISSEN et al. 2018).

The hierarchy of birds is determined by the pecking of another individual in their group, where a chicken's social position is determined by the number of individuals it pecks, with the dominant individual pecking all the others without being pecked back and the most submissive individual being pecked by all. The rest can form a linear pecking order, in which a complete order of positions in the dominance ranking of the individuals occurs. Pecking triangles can also occur among the remaining individuals (GUHL 1945, IZAR et al. 2006).

In a group of individuals, it is possible to encounter diverse situations. A circular structure (that has no established hierarchy) may occur when everyone pecks, as well as being pecked. There can also be a total or partial hierarchy in groups. When we observe the presence of total hierarchy it means that all individuals in the group can be compared, for example, given individuals (x, y, z), if x won a confrontation with y, and y won a confrontation with z, most likely x would win a confrontation with z. Whereas in the case of a partial hierarchy, the individuals are all at the same hierarchical level, for example, given individuals (x, y), individual x neither wins nor loses a confrontation with individual y (IZAR et al. 2006).

Feeding is one of the biggest moments of conflict and also the moment of trying dominance and establishing hierarchy. As a result, tolerance develops, and several birds may feed with only the posture of a threat being enough to maintain or strengthen social relationships (GRANDIN 2019, GUPTA SHAILESH et al. 2015). The results of NEVES et al. (2015) indicated that the feeder type could have influenced the birds'

behavior. A higher percentage of birds effectively eating were found in the one with the largest free area to access the food.

A large group of birds can also generate aggressive behavior because it is hard for individuals to establish a stable dominance hierarchy. High population densities result in frequent space violations. To prevent this from occurring, the birds must recognize individuals and remember their social position, which provides stability to the group. Mixing groups results in re-establishing domains with associated agonistic interactions, often resulting in adverse performance effects. When fully established and stable, social hierarchy reduces the incidence of aggression in a group (BHANJA & BHADAURIA 2018).

Social space

Chickens require an absolute three-dimensional space to perform basic body movements. They may also prefer to keep distance from other birds, and interindividual distance may vary according to activity. The relationships between the effects of available space and the group size on bird behavior are not yet well understood (WIDOWSKI et al. 2016). Dust bathing, feather cleaning, resting, moving and egg-laying are activities that birds would like to perform together (CAMPBELL et al. 2016, BOZAKOVA et al. 2017).

Drinking behavior

Water is fundamental in animal nutrition, and it also plays an essential role in the physiology and metabolism of birds, acting in thermal homeostasis, food digestion, and waste elimination (KHOSRAVINIA 2015). The regulation of water intake in these animals counts on two voluntary mechanisms of action: cellular dehydration and the renin-angiotensin system, which act to stimulate thirst, and can be influenced by several extrinsic and intrinsic factors in birds (VAN DER KLIS & DE LANGE 2013). Birds can have their water intake influenced by diet, in which diets rich in soluble fiber induce a daily water intake of 2.5 times higher (NIELSEN et al. 2011). As well as the physical form of the diet, the pelleted and ground diets induce greater intake when compared to bran diets. Regarding temperature, increasing 1 °C above the thermal comfort zone, we also improve the water consumption by up to 7% (VIOLA et al. 2011). Water helps to reduce the body temperature of birds (LARA & ROSTAGNO 2013) because when subjected to heat stress situations, they may have a thermoregulatory imbalance in their metabolism, which can lead them to death (BRUNO et al. 2011, LI et al. 2015, KHOSRAVINIA 2015). Moreover, the water intake can differ depending on the season, each 1 g of food ingested by birds increases 2 to 3 ml of the water during winter, while in summer, it increases to 4 to 5 ml (SAEED et al. 2019).

Light is another environmental factor that can influence water consumption. Studies show that birds can have two distinct intake peaks: after the start of the light period and before the start of the dark period. The reduction in water consumption occurs one hour after the dark period starts, indicating that birds anticipate this period (VILLAGRÁ et al. 2014). In addition, the consumption of water behavior of birds can be influenced by the type of drinker used in production. Also, birds spent 6% of their daily time drinking water in nipple drinkers, while pendular drinkers spent 2 to 3% of the time drinking the same amount of water (BRUNO et al. 2011).

Concerning intrinsic factors that affect the water intake, we can mention the age of the birds, which as it grows, the intake gradually increases, going from 225 ml/hen/week for one-week-old animals, to 2000 ml/hen/week for eight-week-old animals (WILLIAMS et al. 2013), increasing the frequency of visits to the drinkers as expected biologically and physiologically. Also, there is a difference in water consumption between modern broilers and jungle fowl (ORLOWSKI et al. 2017). When compared broilers grown in 1991, 2000, and 2001 with 2010-2011 the dairy water consumption of the 2010-2011 group was significantly higher, which is probably due to differences in genetics (WILLIAMS et al. 2013).

Birds prefer to drink together with others. Therefore, when introducing new birds to the flock, they will usually learn from the older ones, but when housing a whole new flock, more assistance, and attention are needed to ensure the birds find the water source. In addition, it has been observed that birds develop a characteristic consumption when they receive water *ad libitum*, but this pattern is variable according to water availability and management. When water-restricted birds receive water, they ingest all the possible amounts until reaching the physical limit of the crop, and after they look for food, cases of regurgitation are frequently observed (VIOLA et al. 2011).

Feeding behavior

Feeding behavior is controlled by mechanisms between the brain and gut, including neural and hormonal pathways that reflect hunger or satiety. Layers prefer to feed under bright light (200 lux) and avoid low light (<1 lux). Moreover, birds spend 14% of their total time feeding when lighting is low compared to 39% of the time spent feeding in bright lighting (PRESCOTT & WATHES 2002). Broilers also prefer to eat

with higher light intensity (20 lux) compared to 5 or 10 lux (RACCOURSIER et al. 2019). Therefore, this fact is of crucial importance for broilers to maximize zootechnical performance.

BOKKERS & KOENE (2003) found pre-prandial correlations for broilers but, the same effect was not found for post-prandial mechanisms. Thus, feeding behavior in broilers is controlled more by satiation mechanisms than by hunger mechanisms. Although for layers both correlations were significant, in other words, the feeding behavior is controlled equally by satiety and hunger mechanisms. HESHAM et al. (2018) observed that broilers increased eating behavior when subjected to blue light compared to red, yellow, and green lights. WIDOWSKI et al. (2017) observed an increase in feeding behavior in laying hens at 5:00 pm, this is mainly because egg formation occurs at night.

Another interesting behavior showing up by birds is that they work for food, even in the presence of ad libitum food. This is known as counter-free loading. For example, chickens will peck at an object if they know they will receive a food reward, even if they have the same food freely available in front of them (FERREIRA et al. 2021).

Broiler chickens with 3 feeders with different spaces increased the feeding time and the number of visits in a feeder with 2.3 cm/space compared to birds that were submitted to only 1 feeder with a space of 2.3 cm/space. However, increasing the feeder space from 2.3 to 6.9 cm/bird with the same amount of feeder didn't increase the number of birds consuming at the same time. Therefore, birds are attracted to food when they see others eating, and the number of feeders and their placement in the house is more important than just increasing the number of feeder/bird spaces (LI et al. 2021).

Furthermore, as the age of the birds increases, the chickens spend less time feeding and visiting the feeders. This fact occurs because as birds get older, they become lazier due to increased body weight. Also in this context, broilers with different social hierarchies may show individual variability within a group, in which dominant birds have priority to access the feeders, while subordinates often cannot access the feed freely. However, one of the advantages is that broilers occupy the feeders for less than 60 seconds in each visit, so the birds don't need to wait much longer to get access to the feeders and, therefore, reduce their frustration (LI et al. 2021).

Sexual behavior

The study of the sexual behavior of birds is of extreme importance, through this it is possible to recognize their manifestation, once the main objective of a breeding flock is the production of fertile eggs, therefore the reproductive capacity of both males and females is a crucial factor (MARIN et al. 2014).

Physiologically, behavior is influenced by neurobiological and hormonal aspects (ZABUDSKII 2017). Regarding male sexual behavior, cover attempts are observed more frequently (10 to 30 covers during the day) in the afternoon (MOYLE et al. 2010), considering that egg production is reduced at this time, about male the daily sperm production can be considered fairly constant regardless of mating frequency, because the production gets close to 100 million per gram of testes weight (KHARAYAT et al. 2016).

Stratification is one of the main factors affecting the sexual behavior of birds because dominant males show more active behavior when compared to dominated ones and, this category of males covers females in higher hierarchical positions, as they are less active and more easily accept the cover (PIZZARI 2016). Heavier roosters showed more sexual displays and a higher frequency of covering (FRAGOSO et al. 2012). Sexual courtship behavior is performed before the cover and involves wing movements and vocalizations from males to females. It is usually exhibited by the dominated males instead of heavier ones (PEREIRA et al. 2017).

Density and large group sizes are other factors that influence the sexual behavior in birds, because the stress generated by space disputes, and the production of corticosteroids interfere with social behavior (DE JONG et al. 2009, RIBER et al. 2017). The management during weaner can also influence the sexual manifestation of males. When both sexes are raised together in a free-range environment was noted that hens are able to express mating behavior, however, in pens facilities, no discernable behavioral differences were observed (XIANG et al. 2021). In conventional production systems, the number of mating possibilities decreases, resulting in increased competition among the roosters, all these conditions impact stress and sexual aggression. Nevertheless, the expression of the sexual behavior of birds when appropriate is an extremely advantageous manner because it allows the possibility of improving reproductive results (RIBER et al. 2017).

Undesirable behaviors

Domestication and genetic manipulation have brought changes in animals' life. Due to these changes, animals have developed abnormal behaviors (BRUNBERG et al. 2016). Some of them will be mentioned in the next subtitles.

Feather pecking and cannibalism

Feather pecking is a problem mainly observed in layers, and because of this factor, pecking is widely used in laying poultry to prevent cannibalism. However, cannibalism usually occurs in stressed, high-density, welfare-poor animals (MAZZUCO 2008, LAGANÁ et al. 2011).

It is important to remember that not all pecking is aggressive. One form of pecking that occurs in birds is known as feather pecking, which has two different forms: gentle pecking and severe pecking. However, both are defined as abnormal behavior. In gentle pecking, the pecks are light and usually do not bother the receiving bird, unlike severe pecking, which consists of the pull feathers out from the other bird (GENTLE 2011, ANGEVAARE et al. 2012, CARRUTHERS et al. 2012, NICOL et al. 2013). Although such behavior can be performed in different degrees of severity, the severest form can lead to cannibalism, defined as the destruction or ingestion of the tissue or skin of another animal of the same species, and usually occurs in anatomical regions like the base of the tail, neck, and chest, besides being a possible factor in increased mortality (ANGEVAARE et al. 2012).

Some authors believe that feather pecking is directed at foraging and tends to be exacerbated when birds cannot demonstrate this behavior or when there is no positive feedback (ICKEN et al. 2017). As a suggestion to decrease feather pecking: genetic selection, density adjustment, supply of foraging material, and provision of perches (NICOL et al. 2013).

Stereotyped behaviors

Stereotypic behaviors are important indicators of animal welfare, as they are considered abnormal activities. These behaviors do not have a specific goal and always repeat the same pattern and the same sequence (ZAPLETAL et al. 2011). It is believed that these behaviors happened due to intensive production. High stress caused by environmental and management systems is also associated with high corticosterone levels (WILLIAMS & RANDLE et al. 2017). Polydipsia, or excessive thirst, is observed in broilers. It is believed that increased water consumption is a stereotyped form correlated with the level of feed restriction imposed on the animals (SAVORY 2010).

The foraging occurs in the natural habitat of birds and, it is observed that they spend an average of 50% of their time performing this activity, in which a wide variety of plants and animals are available. However, animals in captivity have their foraging activity suppressed because of the physical space and the balanced diet that is easily accessible. Thus, with the suppression of foraging, animal behavior tends to be expressed inappropriately as a result of environmental stress and boredom (SAVORY 2010).

To try to reduce or avoid these behaviors, enriched environments should be provided. RIBER et al. (2017) suggested that vertical panels in the litter area, elevated resting places, substrates and diluted diets seem to be promising broilers enrichments. For layers, litter provision (TAHAMTANI et al. 2016), brooders (JENSEN et al. 2006), dust bathing, perches, and nest (ZIMMERMAN et al. 2000) can also help to reduce stereotypic behaviors.

Egg ingestion

Hens usually do pecks in eggs because of curiosity or to try to satisfy a nutritional deficiency, usually of calcium or vitamin D. Measures to control or prevent such behavior are to reduce stress (provide nests and perches before the hens start laying so they learn to use them) and provide adequate feed (JACOB 2021).

Bedding ingestion

Litter ingestion is more common in broilers than in layers. Litter consumption can be influenced by the type of material used and can affect weight gain and immunity, as well as the impact on the gastrointestinal tract (TAHERPARVAR et al. 2016). Young birds can also consume litter as a way of exploring the environment and, for this factor, the litter should be covered with paper (newspaper or cardboard), and gradually removed until the birds learn to eat ration (BASSI et al. 2006).

Smothering

Smothering in poultry occurs when birds mass together in floor-reared and can cause death from suffocation (BARRET et al. 2014). This behaviour is poorly understood because it is unpredictable and difficult to induce experimentally, and it's also disrupted by the presence of an observer (HERBERT et al. 2021). Authors believe this can happen for behavioral reasons like a panic reaction, social behavior (protect against danger), or attraction for something like feed or environment exploration (BARRET et al. 2014, WINTER et al. 2021). Also, synchronized behaviors such as dust bathing and attraction to conspecifics could be a possible reason for hens to the crowd (CAMPBELL et al. 2016).

WINTER et al. (2021) observed that pilling behaviour occurred more frequently at midday and in the afternoon, also the pile size was smaller in the afternoon when compared to the morning and midday.

Furthermore, brown flocks piled less frequently but with more hens involved per pile at 20 weeks compared to 30 weeks, which relates to flock age and genetics. They also observed that the trigger to begin the piling was stronger when a single bird pecked at an object and the others followed, which they believe is explained by facilitation behaviour.

Future perspectives

Future studies on behavioral expression are necessary to encourage the poultry chain to monitor and interpret, more effectively, poultry behaviors, thus optimizing the life of these animals and, consequently, their productivity. Furthermore, advances in automated technology have gained a lot of space in the last publications and can help the food chain understand animal behavior, improve animal welfare, and attend to consumers' demands.

CONCLUSIONS

The behavioral actions of the birds reflect their welfare state and are related to environmental, genetic, and physiological factors. Therefore, the correct interpretation of expressed behaviors, including their frequency, duration, and sequence, can be used to estimate their welfare.

ACKNOWLEDGEMENTS

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Brazil) and by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, Brazil).

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