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REVIEW
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# Farm animals's cognition and the tests used on its evaluation

*Cognição de animais de produção e os testes utilizados na sua avaliação*

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**Abstract** Cognition is a set of activities and processes whereby an animal acquires information and develops knowledge. The most common cognitive processes are: memory, categorization, attention, reasoning and language. This present research was aimed to study the cognitive ability of livestock based on results of cognitive tests described in the literature, as well to expose the various types of tests applied to make such an assessment, in the periods from 1969 until nowadays. Through this bibliographic study, it was discussed issues related to cognition, sentience and animal consciousness, through preference tests, learning, recognition and memorization applied to domestic animals. In general they show a cognitive ability to evaluate the environment for themselves, based on their preferences and motivations. Cognitive tests have shown the high ability of some species to memorize their handlers' faces, and recognize who is aversively dealing with. Furthermore, it was possible to prove that some producing species are sentient and their choices able to imply physical sensations that can affect your mental state. Thus, it is important to point out measures to help improve the well-being of the animals.

**Keywords:** animal sentience, memory, motivation, preference test, welfare

**Resumo** A cognição é o conjunto de processos pelos quais um animal adquire informações e desenvolve conhecimento. Os processos cognitivos mais comuns são: memória, categorização, atenção, raciocínio e linguagem. A presente pesquisa teve como objetivo avaliar a cognição de animais de produção baseado em resultados de testes de cognição já descritos na literatura, bem como expor os diversos tipos de testes aplicados para realizar tal avaliação, desde o ano de 1969 até o momento. Neste levantamento bibliográfico foi discutido aspectos relacionados à cognição, consciência e senciência animal, por meio de testes de preferência, aprendizagem, reconhecimento e memorização aplicados à animais domésticos. Em geral os animais apresentam uma capacidade cognitiva de avaliar o ambiente em relação a si próprio, com base nas suas preferências e motivações. Os testes cognitivos têm mostrado a alta capacidade de algumas espécies em memorizar o rosto dos seus tratadores, além de reconhecer os que os tratam de forma aversiva. Por conseguinte, foi possível comprovar que algumas espécies destinadas à produção são sencientes, sendo as suas escolhas capazes de implicar em sensações físicas que podem afetar o seu estado mental. Assim, torna-se importante apontar medidas que auxiliem na melhoria do bem-estar dos mesmos.

**Palavras-chave:** bem-estar, memorização, motivação, senciência animal, testes de preferência

## Introduction

The researchers' attention has been focused on the discovery of animal welfare indexes, which uses the animal itself as an indicator. With the aim of helping in this discovery, the studies are focused on assessing the cognitive abilities of animals by test applications, to check their degree of satisfaction or preference when subjected to certain environments, as a way of delving into aspects of animal consciousness and sentience.

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The importance of the study of animals' cognitive abilities is related to the context in which the suffering may occur or be avoided (Mendl and Paul 2004). For instance, the ability to plan an event in the future or to anticipate a particular occurrence are cognitive processes that may have very relevant consequences in the management of situations which may promote suffering.

The animals' cognitive abilities can be assessed indirectly, making use of behavioral indicators (Pedrazzani et al 2007; Hotzel and Martendal 2010). For this purpose, they are used tests of preference, motivation, memory and learning, which have been applied mainly in livestock, aiming to seek improvements in their life conditions and at the same time, increase their productive indexes.

The advantages of applying these tests in animals are the convenience and the lower degree of invasiveness. However, some precautions must be taken to ensure that the results are reliable and really demonstrate the animal's degree of reasoning and its consequent ability to evaluate the environment.

As a result, the present literature review aims to demonstrate the various types of tests to evaluate the cognitive capacity of livestock already described in the literature.

## 1. Animal cognition, consciousness and sentience

Cognition refers to the mechanisms by which animals acquire, process, store and act from the stimuli of the environment. These mechanisms include the perception, learning, memory and decision making (Shettlewprth 1998). From the animal cognition, the animal's consciousness may be checked, i.e., the ability to assess and deduct the meaning of a situation in relation to itself during a short space-time (Duncan 2006). In addition, associated with consciousness, there is sentience, that is the ability of an animal to undergo situations caused by pain, to see and to feel (Dawkins 2006).

It is worth noting in this context the difference between cognition and consciousness. The cognition helps the animal to deal with the outside world in a flexible way. The consciousness would be as an "interior vision", which allows the animal to have knowledge of its interior, as fear and pain (Duncan 2006).

The acceptance of the fact that animals are aware of their choices, and that it is possible to obtain information about what they are feeling by them, has provided major discussions in the scientific community. The importance of this fact is clear in studies that highlight the fact that the animals are not only sensitive to simple stimuli, but also, are endowed with processes such as memory and learning, to help them face challenges and choose favorable situations according to their physiological and behavioral needs (Duncan 2006, Broom et al 2009).

As stated by Broom et al (2009), there are four levels of consciousness (Table 1). According to these levels, the individual can not only be sensitive to stimuli, but can also have the memory of events and mental images of events that can be used to make appropriate decisions, as well as to avoid negative consequences and to increase the positive ones. It is believed that animals have, at least, these basic types of consciousness that give rise to problems that can interfere with their well-being (Dawkins 2006).

Interwoven with brain phenomena of intelligence and conscience there is the animal sentience, whose definition is associated with the ability of an animal to experience sensations (Boyle 2009).

The studies of sentience involve methods of motivation, decision-making and assessing whether an animal is motivated to obtain or avoid a resource, whether it prefers alternative resources and how strong is its motivation or preference, and the environmental influence on these changes (Kirkden and Pajor 2006).

**Table 1** Description of four levels of consciousness.

| Levels of consciousness | Description |
|---|---|
| Perceptive | Evidenced when a perceived stimulation results in an automatic reply that the individual may or not be able to voluntarily modify. |
| Cognitive | Cerebral processing of sensory stimuli, or constructions on the basis of the memory results in a flexible response. |
| Evaluation | The individual is able to assess and deduce the meaning of a situation in relation to himself over a short space-time. |
| Executive | The individual is able to evaluate, infer, and plan in relation to his long term intention. |

Source: Sommeville and Broom (1998)

Associated to motivation and decision methods, there are different methods to monitor emotional processes of animals, by assessing behavioral and/or physiological changes (Imfeld-Mueller et al 2011).

To assess animals' feelings using behavioral analysis, two approaches become important. One of them involves giving the animal some control over its environment and observe the decisions it takes. The other involves the observation of animal's responses when it is confined in an environment or subject to deprivation, frustration or suffering (Kirkden and Pajor 2006).

In relation to the assessment of animals' feelings through the assessment of physiological parameters, there is the study carried out by Waynert et al (1999), in which they observed that cattle handled with shouts had higher heart rate in relation to the treatment with metal clang. It shows that shouts during cattle handling should be avoided as they increase fear and make the management more difficult.

## 2. Cognitive tests applied to livestock

The Brambell committee (Command Paper 2836 1965) ensures that the feeling (emotional state) should be answered when animal welfare is discussed, in addition to pointing out that animals' feelings are probably different from human beings. However, they may experience emotions, such as anger, fear, anxiety, frustration and pleasure.

Evaluating animals' mental experiences is difficult, but it can be performed by using careful approach, applying various types of cognitive tests, as shown in Table 2.

**Table 2** Description and applicability of different types of cognition tests used in the livestock production chains

| Types of cognitive tests | Applicability in livestock systems | Livestock system |
|---|---|---|
| Learning and retention by animals | Reallocation of preferred areas to rest, safely explore place of accommodation and avoid areas where dominant or unknown animals are generally located | Birds, sheep, horses and pigs |
| Test of image recognition | Smaller effect of social isolation, decrease of stereotypies and aggressiveness | Sheep, rabbit, cattle, pigs and horses |
| Recognition of stockpeople by domestic animals | Decrease of animals' fear of stockpeople, greater ease of handling and less negative interference in the production | Cattle, horses, pigs and birds |
| Preference of environments | Decrease of stressful environmental factors influence on animals | Cattle, pigs, goats, birds and sheep |
| Preference of types of object and food | Attract the animals' attention to food and to the equipment, facilitate the expression of natural behavior as well as decrease the boredom of the accommodation place | Birds, pigs and cattle |

Certain alterations in the physiology and/or behavior of an animal can be indicators of impairment of its welfare, because they are tools which an animal have to overcome inadequacies present in their environment and are used more intensively when the encountered degree of difficulty increases (Molento 2005). These alterations are intimately linked with their affective experiences, and for this reason, they become a disturbing factor to have a satisfactory life, i.e. free of suffering prolonged or intense pain, fear, hunger and other negative states (Fraser et al 1997).

The fear, being a negative stimulus, can result in bustling by the animal with consequent elevations of stress hormones, which can compromise some productive parameters (Grandin 1998; Grandin and Hauser 2002). Therefore, the welfare is entirely a matter of cognitive, psychological and mental needs of animals (Duncan and Petherrick 1991).

In this way, it is important to deepen the discovery of the animals' mental abilities as a way of improving their living conditions in production systems.

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2.1 Test of learning and memorizing by animals

Several studies related to the memory capacity of domestic animals were made with the intention of discovering neurological and psychological aspects in relation to its decision-making and choices.

Mendl et al (1997) affirm that well developed spatial memory skills in animals help them in some tasks. The same authors argue that in order to demonstrating a viable preference for a given stimulus or feature, the animal needs to be able to associate the feature to its location, reminding them that the "value" of different locations and select them in accordance.

According to Cahill et al (2001), the ability of learning or memory can only be inferred from behavior. These authors argue that in relation to this ability, the tests should be applied with caution to ensure that there are no wrong conclusions in relation to the behavior of the evaluated species, since the behavior is affected by many factors, and not only by learning and memory. As an example, Laughlin et al (1999) made eight mazes with compartments available to pigs, where only four of them had food. The results of this study provide additional evidence that subversive environment influence, such as placing a strange animal, may affect these animals' ability of memorizing the places with food. However, without the environmental interference, these animals have demonstrated accuracy in memorizing the place where the food was.

For Broom (2007), the verified learning after the tests of learning and memory is not, in itself, proof of consciousness, but it is an indicator that a more in-depth investigation of cognitive capacity may reveal the existence of consciousness compatible with the sentience, as shown in the study carried out by Imfeld-Mueller et al (2011). These authors evaluated the ability of pigs to distinguish sounds and associate them with positive and negative situations. In the positive situation, the pigs passed through a corridor and at the end of this there was food. In the negative situation, the pigs went through a ramp and there was no food reward. For each of the situations there was a type of sound. Through this study, it was possible to observe the distinction of sounds performed by pigs due to the behavior of a leak and high frequency vocalizations have been higher in negative situations.

In relation to the birds, the authors Vallortigara et al (1998) found that the chicks have cognitive abilities able to detect where your social companion was seen for the last time. Second Broom (2007), this can be justified because the chicks, which are gregarious animals, usually have a higher complexity in the operation and development of their cognitive capacity in relation to animals that do not show social behavior.

Even in relation to the chicks' memory length by means of social incentives, Regolin et al (2006) also verified that chicks have good memorizing capacity to find objects. These authors confined chicks behind a transparent partition and later, behind an opaque one. Then, they placed behind one of the two identical screens a social object or food to analyze the ability of the bird to memorize and choose between the two options in order to finding their objective (object/food). The study showed that these animals remembered to choose the screen of their choice in all hold intervals for the two types of partitions. However they were better finding the social object than food.

Moreover, satisfactory results were found by Etienne (1973) in relation to the chicks' memory as a means to assist in the search for food. This author has placed these birds between two screens and larvae of beetle protected by a glass tube. The larvae were pulled in a single direction and disappeared behind a screen. In short, the chicks without preliminary experience of any training situation, easily learned to be rewarded in test to go behind the screen. The search behavior that all acquired was to circulate behind any screen and change over from one screen to the other, were the larva, being rare times in which these animals were beyond this stage.

The horses also have the capacity to memorize food location. Baker and Crawford (1986) evaluated the ability of horses to learn the location of their food after watching another horse finding its food in one of the two buckets of feed. By carrying memorization tests in these animals, they verified by trial and error that horses which have obtained number of hits above the average found their food in less time, in relation to those who have had number of hits in average or lower.

For the sheep, the characteristic of excellent long-term memory owned by these animals can be used to improve their handling efficiency, especially when manipulations that cause fear to the animal are performed. Hutson (1985) checked that food rewards significantly reduce the amount of required effort for the handling of sheep. In addition, they have good long-term memory in relation to handling procedures which they experience (Hutson 1985).

Given the current requirements on agricultural practices related to restriction of livestock's natural behavior, tests such as this are of extreme importance, from the point of view of handling and welfare progress which may be achieved.

2.2 Image recognition tests

Tests of image recognition are of extreme importance for the evaluation of the animals' cognitive capacity, because that indicates their level of consciousness, and thus their level of understanding, assessment, analysis,

and remembering their experiences. For these observations, in other studies mirrors were used to assist in their acknowledgment and recognition of familiar images (Broom et al 2009; Jones 2013).

According to Jones (2013) the mirror test, as an indicator of self-awareness, can demonstrate if individuals can recognize themselves after seeing their image. According to the author, one of the ways to check how the animal reacts is putting a mark (usually a small red dot) on his forehead (or another part of its body) that is not easily visible to the same. If the animal touches the spot on its own body, instead of the image of the spot in the mirror, it indicates that the animal is aware that the image is of itself. A second method is to observe whether the animal uses the mirror to examine parts of its body which cannot be seen in another way, for example, touching or examining its eyes or teeth. This means that the animal recognizes its image in a mirror as an image of itself, which says that the animal is self-conscious.

According to Broom et al (2009), if an individual is conscious, the assessment estimation is that having an innovative visual experience, such as the viewing of images in a mirror, he will learn about what he sees in the mirror in relation to himself, and then he will use that information later. These authors demonstrated this fact in an experiment conducted with pigs, concluding that these animals have made associations by means of visual stimuli, observing the characteristics of the surrounding environment in order to obtaining food reward by using the mirror to locate the food.

Besides being efficient to identify animal's self-consciousness level, some tests of image recognition have shown that the mirror used in these tests exerts positive effect as environmental enrichment, decreasing the environmental adversity caused by social isolation in certain gregarious species, which can lead to stereotyped behaviors and aggressiveness.

Parrott et al (1988) found that sheep, in tests with "mirror" and "without mirror", showed considerable interest in the mirror. According to this study, they were observed higher levels of cortisol and lower levels of prolactin (which tended to increase gradually) in the treatment "without mirror" in relation to the treatment "with mirror", which showed a stress response. The result of this study shows that the self-perception and acknowledgement exert positive effect on animal.

Chu et al (2004) claim that when individually housed, rabbits can have their welfare compromised thus expressing greater aggressiveness. However, the use of mirrors can decrease this aggressiveness. As noted by Jones and Phillips (2005), the presence of mirrors in the environment stimulates exploration by rabbits. When the rabbits are in contact with mirror, their reaction is shaving it and smell it in an attempt to achieve their images.

In parallel, studies developed by Dalle Zotte et al (2009) showed that the availability of environments with and without mirror to rabbits, revealed that 72% of the rabbits preferred the environment with mirror, being that this preference decreased with aging. Furthermore, even in the dark stage, rabbits preferred the mirror area. This fact can be related to the association of the area with the presence of same species members, which are acknowledged by their senses.

This fact was evidenced in chicks, as they are also gregarious animals, the separation of same species members produces an increase in vocalizations of anguish and a decreased response to noxious stimulation. Feltenstein et al (2002) observed that isolated chicks gave a greater number of vocalizations of distress in relation to the birds tested under the social condition, and, in the presence of mirrors these vocalizations were reduced.

In cattle, the use of mirrors also shows positive effects on the reduction of tension originated from social isolation, when handled individually. According to Piller et al (1999), when *Angus* heifers are weighed in the presence of a mirror with side view or front of themselves, the animals with access to front view obtained the lowest heart rates compared to those who were with access to side view or without mirror.

The same effect of the aforementioned study can be evidenced in horses. McAfee et al (2002) verified that a mirror can minimize the social isolation in the stable, provide environmental distraction or visual stimuli, changing the perception of the horses to the environment and the responses to it, such as the reduction of stereotypies.

## 2.3 Test of stockpeople recognition by animals

The stockperson's attitudes influence his or her interaction with animals and, consequently, on the success of the farm (Waiblinger et al 2002; Da Costa 2003; Hötzel et al 2005). In respect of dairy cattle, these attitudes are related to the cow's fear of human beings and their effects on the animal behavior and milk production (Oliveira et al 2014). In other studies, it was found that in farms where stockpeople negatively interact with cows during milking, the milk yield was lower, so it is essential to handling animals in a positive and rational way. When the stockperson approach with positive interactions and with a low percentage of negative behaviors in the milking parlor, the dairy cows get closer to humans (Waiblinger et al 2002; Peters et al 2010).

This occurs because in some situations the animals are able to discriminate among people and in others, they generalize the people who handle them (Passille et al 1996). In accordance with Da Costa (2003), this type of reaction occurs through a form of learning, the conditioning (or associative learning), through which the animals establish

links among certain situations (involving people, places, etc.) and sensations. The same author states that if the sensations are negative, the cattle seeks to avoid the situations associated with them by fleeing and fighting, which complicate their handling.

Calves, as well as adult cows, show that can easily distinguish between different people based on their previous experience. They can develop a general fear of people as a result of aversive handling. As a result, there may be interference in the production, as an increase in the residual milk, in addition to increasing the reactivity of animals and their heart rate. Since the fear of cows is lasting, positive manipulation becomes necessary in order to minimize it (Passille et al 1996; Rushen et al 1999).

Hötzel et al (2005) stated that when they are handled in aversive manner, there is an increase in their flight distance. In parallel, there is an increase in the elimination of feces and urine by animals (Munksgaard et al 1997).

As a way to minimize the effects of aggressive handling, some interventions are extremely necessary, such as stockmanship training to improve human-animal interaction (Boivin et al 2007). Researchers have shown that these types of training resulted in a smaller flight distance, indicating a lower level of fear. In farms where the levels of fear haves decreased after the intervention, there was a higher milk production in relation to the other farms. Similar effects of treatment were observed in the level of milk protein and fat (Hemsworth et al 2002).

The recognition of handlers by the cows can be related with the color of the clothes or the face, using recognition clues, such as, height of the body and face. However, using the face becomes difficult when the cows cannot see the rest of the body (Munksgaard et al 1997; Rybarczyc et al 2001). Taylor and Davis (1998) observed that *Holstein-Friesian* adult cows have the ability to learn to differentiate handlers even with equal clothes, in order to obtaining a reward. In this study, they have learned to press their nose on the right wrist of the handler to obtain a reward. The experiment consisted of two handlers, one responded to the animal giving food and the other did not. The results showed higher frequencies of responses to the handler that conferred a benefit with the food in relation to that did not confer any benefit.

This human-animal interaction can be maximized in accordance with the frequency of contact between handlers and the animal. Then, the reduction of fear leads to ease of handling of the animal and ease to be loaded to transport. Studies have reported that calves that received human contact with frequency, such as affection, interacted with greater frequency with unknown persons, in relation to those who received no contact (Lensink et al 2001). In addition, animals that received additional contacts were loaded with greater ease to transport. This fact demonstrates that the greater contact, as the affection given by handlers, decreases the fear and facilitates the animal handling, decreasing the flight distance and the cortisol rate (Breuer et al 2003).

Other species also show positive behavior when linked to a not aversive treatment. For instance, when 1 to 3 year-old sheep be in contact with humans, they increase socialization with their handlers, with consequent reduction of fear (Markovitz et al 1998).

The handlers' facial recognition can also be carried out by horses. After performing training using operant conditioning tests to examine whether horses could recognize photographed human faces, Stone (2010) noted that they have learned to discriminate photographs of not affiliated individuals and fraternal and identical twins.

As well as the horses, pigs can also distinguish handlers only by their faces. In a study conducted by Koba and Tanida (2001), they were used two handlers wearing same color clothes, olfactory and auditory clues, and one of the handlers was responsible to reward the pig by success of choice, after going through a maze. The results indicated that, even without the auditory and olfactory tips, pigs are able to distinguish people.

For female pig, the non-aggressive treatment can also assist in the process of oestrus detection. Research carried out by Hemsworth et al (1996) showed that the animals which associated the presence of a handler with receiving food reacted more fearlessly during oestrus detection procedure than that animals which were not fed (Hemsworth et al 1996).

In addition to increased fear, when aversive conditions are offered to pigs, they tend to defecate and urinate more frequently, try to escape, have less tail motion, present acute vocalizations and social isolation (Reimert et al 2013).

Regarding laying hens and broiler chickens, the distinction between the type of handler in relation to the garment color does not occur. However, the animal's fear of a handler can be reduced by means of regular handling. This constant manipulation also reduces the behavioral inhibition, such as the reactions of tonic immobility and the avoidance behavior to the experimenter, in addition to lower levels of corticosterone which facilitates handling and improves animals' performance (Jones e Faure 1981; Jones e Waddington 1993; Barnett et al 1994; Hemsworth et al 1994). This fact evidences that human contact can influence the bird behavior, production and welfare.

## 2.4 Preference tests

Preference tests are resources available to the animal as alternatives of choice. These resources can become "alternatives" through different ways to meet the individual

(Kirkden and Pajor 2006). Through these tests, you allow the animal to choose among certain aspects of their environment, with the logic to choose according to their feelings, thus, what better promotes their welfare. These tests represent only the first step to "ask" an animal what it feels about its environment (Molento 2005).

Many of cognitive decisions are governed by awareness of the potential consequences of actions related to feeling (Panksepp 2006). This way, the tests of choice are efficient to measure animals' cognition ability (Laughlin et al 1999). These tests have been used in studies of animal welfare, in which the choices are usually interpreted from a motivational perspective, as a way of demonstrating the importance, value, or aversion of particular resources or incentives to the animal (Mendl 1999). Thus, they are focused on the following aspects: if an animal is motivated to obtain or avoid an appeal; its preference among alternative resources; how strong its motivation or preference and if its preference, or the strength of its motivation or preference is altered by changes in their internal or external environment (Kirkden and Pajor 2006).

According to Duncan and Petherick and Duncan (1991) "animal welfare is solely dependent on mental, psychological, and cognitive needs of animals of interest". From this statement, it is assumed that if the mental needs of those are matched, the physical needs will be in the background. Therefore, the tests of preference are extremely important because they permit to check animals' needs, which can positively contribute to their handling and are also important welfare indicators.

The contribution of these tests to changes on handling according to animals' preference can be observed in a study conducted by Baldwin and Start (1981), who measured the sheep's preference for light or darkness. The animals were placed in chambers where they could turn the lights on or off with a switch, using their snouts. The experiment showed that these animals prefered light, which can assist in the farm management in order to attending animals' environmental preferences.

Hughes and Black (1973), using a preference test with chicken coops wire and other floors, concluded that wire from chicken coops was probably more comfortable than the alternative suggested (floor), because the hens spent more time in chicken coops wire that other floors when the floor options were offered to choose.

2.5 Implications of using preference tests

Several studies have already been carried out with the aim to observe livestock's preference (Abeyesinghe et al 2001; Baldwin and Start 1981; Jones et al 1996; Legrand et al 2009; Muller and Uden 2007), however, it is extremely difficult to conclude on the applied tests, since there are a huge variety of methodologies and different combinations of "alternatives".

As an example, there is a range of scientific results about color preference for laying hens and broiler chickens. However, there is no clear decision for the type of color of objects and favorite food for these animals, becoming really complicated to define a choice (Table 3). This fact can be attributed to the different types of used methodologies and the previous experience of the animal with objects of other colors, with consequent association of the object to a particular color, as well as, the color combinations used as "alternative" at the time of the preference test. However, studies such as these are in fact very important from the point of view of modification of colors of curtains, nests, drinkers and feeders in order to attracting the attention of these animals, positively influence on their welfare and increase their use of such equipment.

As stated by Molento (2005), there are several implications that should be taken into consideration during the application of a preference test. The first objection is that the preference of an animal can be affected by its previous experience. A second problem is whether the results of such experiments are able to provide only relative information. This makes the interpretation of these results difficult. If an animal can choose between the two options A and B, and choose to spend 80% of its time in A and 20% in B, it may reveal that the time used in B probably represents a positive choice (once the animal could avoid B completely in case it considers this condition as aversive) and it is important for animal welfare. A third problem with the preference tests is the possibility of conflict between short- and long-term welfare. A fourth problem with preference tests is that animals may be deceived by unnourishing substances such as saccharin, as well as drugs like alcohol or nicotine.

These cautions proved to be important in research developed by Abeyesinghe et al (2001), whose experiment was carried out to evaluate the preference of broiler chickens for different types of environments. In that study they were offered four compartments with heat treatment (with or without vibration) as an alternative choice to animals, connected by a central zone. The authors highlighted that the birds were sufficiently trained to move through the polyethylene curtains. However, reactions of fatigue, nausea, exacerbation of claudication or fear impacted the ability of some individuals to leave the central area.

According to Molento (2005), the possible solutions are: to offer the animals good sense choices and take into account their natural history; to emphasize the results of choice to encourage long-term animal welfare; to present a diverse range of choices; to apply preference tests followed by motivational tests; to use animals used in tests of preference that have similar previous experiences or include prior experience as a variable in experimental preference

tests. Therefore, it is observed that large developments have arisen in research with the purpose of improving the welfare of animals, by checking the cognitive capacity of them, with the use of an animal itself as an indicator.

**Tabela 3** Descriptions of preferences of chicks and laying hens by different kinds of objects and food color, according to their respective authors.

| Used objects | Used colors and combinations | Preference | Author (s) |
|---|---|---|---|
| Colored cards | 16 colors with varied wavelengths | Orange and blue | Hess (1956) |
| Colored walls | Yellow x blue and red x blue | Red and yellow | Taylor et al (1969) |
| Colored discs | Red x yellow; red x blue; black x blue; black x gray; red x green | Red and blue | Salzen et al (1971) |
| Colored discs | Orange x blue; red x green | Orange (between red or green there was no difference) | Ham and Osorio (2007) |
| Paper circles | Blue x red | Blue (when conditioned in light environment) | Cherfas (1978) |
| Colored walls | Blue x red | Red | Herbert and Slucking (1969) |
| Floors | Paired combinations between violet, blue, green, yellow, orange and red | Preference for blue compared to green | Davis and Fisher (1978) |
| Ropes | White x yellow x red x green x blue | White | Jones et al (2000) |
| Ropes | White x yellow x orange x blue | Preference for bright colors (white and yellow) compared to blue and orange | Jones and Carmichael (1998) |
| Larvae | Red and yellow x only red x only yellow; red and black x only red x only black | Red and yellow; red and black | Roper and Cook (1989) |
| Ration and water | Red x green x black | Red and black | Roper and Marples (1997) |
| Larvae | Red x Brown | Brown | Roper (1990) |
| Ration | Blue x Orange | Orange (when raised in environments with long wavelenght objects) | Miklo´si et al (2002) |
| Ration | Red x yellow x blue x green x bright brown | Red | Rierson (2008) |
| Nest | Blue x green x red x yellow | Chicks exposed to red environments with high light intensity prefered yellow nests | Zupan et al (2007) |
| Nest | Blue x green x red x yellow | Yellow | Huber-Eicher (2004) |

## Conclusions

In general, the animals have a cognitive capacity to assess the environment in relation to themselves, based on their preferences and motivations. Regarding cognitive tests, it is possible to mention that some species have shown high capacity to memorize the face of their handlers, as well as recognize those who treat them aversively. For future research for animals' color preference, it is necessary to apply tests that offer a range of choices and combination of colors as widely as possible. Moreover, they must be followed by motivational tests, as well as a study about animal interaction with the studied color which really shows its preference, in order to avoiding misinterpretations regarding the results.

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