

## BETWEEN THE SPECIES

### The Chicken Challenge: What Contemporary Studies of Fowl Mean for Science and Ethics

#### ABSTRACT

Studies with captive fowl have revealed that they possess greater cognitive capacities than previously thought. We now know that fowl have sophisticated cognitive and communicative skills, which had hitherto been associated only with certain primates. Several theories have been advanced to explain the evolution of such complex behavior. Central to these theories is the enlargement of the brain in species with greater mental capacities. Fowl present us with a conundrum, however, because they show the behaviors anticipated by the theories but do not have the expected changes in the brain. Consequently fowl present two challenges of interest to us here. One is a scientific challenge to explain their remarkable capabilities. The other is an ethical challenge regarding our treatment of animals with higher cognitive skills.

CAROLYNN L. SMITH  
Macquarie University  
klynn.smith@mq.edu.au

JANE JOHNSON  
Macquarie University  
Jane.johnson@mq.edu.au

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## 1. Introduction

Research with nonhuman animals (including primates, marine mammals and corvids) has revealed that these social species exhibit an array of complex behaviors initially believed to be unique to humans, including tool use, problem solving and innovation as well as referential and representational communication. Current theories regarding the evolution of these seemingly advanced cognitive abilities correlate more complex behavior with increases in brain size, yet recent work with captive fowl has demonstrated that they also possess many of these same capabilities, but do not have the predicted changes in brain size. Chickens therefore present a scientific challenge, as well as an ethical one, given their treatment during commercial food production.

In this paper we will begin by outlining the cognitive capacities of chickens as revealed in recent experimental work. We will then move on to show how the theories currently espoused to account for such capacities fail to adequately explain the case of chickens. Finally, we examine some of the ethical implications of this work, including its relevance to the 3Rs that govern experimental research with captive animals.

## 2. The cognitive capacities of fowl

Wild fowl and domestic chickens demonstrate complex cognitive abilities. Fowl communicate using sophisticated vocal and visual signals and show remarkable behavioral flexibility as well as sensitivity to the attentional states of others during social interactions. They also perform abstract and social transitive inferences. Below we will discuss the significance of these capacities as well as the methods used to show that fowl possess them.

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Chicken communication is complex, consisting of over 24 different types of vocalizations as well as visual displays (Collias and Joos 1953). However, the size of the repertoire is not its most remarkable feature. Fowl communicate using signals that are functionally referential (Evans and Evans 1999; Smith and Evans 2008, 2009), and representational (Evans and Evans 2007). These signals are also individually distinctive, which facilitates recognition of individuals (Candland 1969) and the use of reputation in future social interactions (Pizzari 2003).

Functionally referential signals convey information about external events in an environment in the absence of any other contextual cues (the term “functional” acknowledges that the underlying cognitive processes are not well understood (Marler et al. 1992)). Observational studies, followed by experimental manipulation of the signal’s usage, allow researchers to determine the context in which the signals are produced and the responses of the receivers. If a tight correlation between the specific eliciting event and the receivers’ responses is found, the signals can be said to function to convey information about the event and potentially even specific information about how to respond to the event.

Functionally referential communication has been identified in many primate species as well as other mammals such as meerkats (Manser 2001) and perhaps most famously, vervet monkeys (Seyfarth and Cheney 1993). Several species of birds also possess this ability, including ravens (Bugnyar et al. 2001) and chickadees (Templeton et al. 2005). These findings contradict previous assumptions that animal signals only contain information about the affective state (e.g. frightened or aggressive) or about the physical attributes of the caller (e.g., size or health). They further suggest that rather than the receiver’s be-

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havior being a simple reflexive “stimulus-response”, that there may be an intervening cognitive step which involves a mental representation of the event (Evans 1997).

Fowl produce four functionally referential signals, two in response to predators and two in the context of food. The major classes of predators are terrestrial and aerial (McBride et al. 1969). When a terrestrial predator is detected, both males and females produce alarm calls composed of a series of loud, short pulses, which alert the group to the predator’s presence. Members of the group respond to the call by standing erect, scanning the horizon and alarm calling, and may then flee for cover or fly into nearby trees. Terrestrial predators typically hunt using ambush tactics and are more likely to terminate a hunt if detected. The vocalizations may help to coordinate the group’s escape behavior and may potentially deter the predator’s attack. The response to aerial predators is much more nuanced. Unlike terrestrial predators, which rely on stealth to capture their prey, aerial predators rely on speed of attack from a distance, which means that vocalizing in their presence increases the likelihood of being detected and caught. Males hence employ a range of risk compensation tactics during an aerial predator encounter (Kokolakis et al. 2010). The first is to call only in the presence of a female (Wilson and Evans 2008). Although this still increases his risk, it also increases the chances that his mate and offspring will survive, thereby benefiting him through “inclusive fitness”. Second, not all calls are equally risky. By varying the composition and duration of the calls, he can produce a call that is difficult for the predator to localize but that will still alert his mate (Wood et al. 2000; Bayly and Evans 2003). The third factor affecting the likelihood, composition and duration of the calls is the male’s personal risk. Males gave longer duration alarms, which increase the likelihood of signal detec-

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tion by both the female and the predator, when they are close to a refuge (and therefore more difficult to catch). They are also more likely to call in response to their rival's call when they are protected under the cover of a tree or shrub. Lastly, dominant males produce longer calls when their subordinate is nearby. By selectively calling when the subordinate is close by, the dominant may further reduce his risk of capture by giving the predator more than one target (known as the "dilution effect" for predators choosing between multiple targets (Bertram 1978) and the "confusion effect" when prey is fleeing (Schradin 2000)).

The females' response to an aerial predator is also very different from their reaction to a terrestrial predator. Females crouch down and sleek their feathers and only flee once the predator approaches. Females will only aerial alarm call if they have chicks to protect. These behaviors reveal how dangerous an aerial predator can be and hence the importance of being cryptic.

The discovery of food is another important event about which fowl communicate. Upon finding food in the presence of a hen, males perform the tidbitting display. This display is composed of a series of rhythmic motions and pulsatile vocalizations, which are audible up to 30 meters from the male (Davis and Domm 1943). This functionally referential call is individually distinctive and allows females out of visual contact with the male to determine that he has located food (Stokes and Williams 1971, 1972; Evans and Evans 1999). The characteristics of this vocalization (individual distinctiveness and long-distance audibility) enable another suite of interesting behavior in this complex society, including eavesdropping and the use of reputation in mate choice. Females prefer to mate with males,

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regardless of their social rank, that provide food more often to any female in the group (Pizzari 2003). In addition, mating does not always occur immediately after the tidbitting event. This reveals two aspects of the female fowl's behavior: first that females eavesdrop on the food calling behavior of males in relation to other females, and second, that they must remember the behavior of males to express this mating preference (i.e., the individual male's reputation for providing food).

The nature of the tidbitting display also creates a third opportunity. Because both components of the tidbitting display are redundant, a receiver perceiving either component would recognize that the signaler is indicating the presence of food. The subordinate male exhibits behavioral flexibility that takes advantage of this fact. Dominant males respond to a subordinate's food calling and tidbitting display with overt aggression, often chasing the subordinate away from the food and then food calling themselves (Stokes and Williams 1972). To avoid this aggressive response, subordinate males omit the more conspicuous vocalizations and perform only the visual display when the dominant male is attentive. When the dominant male is distracted, the subordinate performs the combined display, which alerts eavesdropping females. This flexibility allows the subordinate to reduce the social cost of calling while still attracting a female. This behavior also reveals that the subordinate is sensitive to the attentional state of the alpha male (Smith and Evans 2011).

The referential nature of food calls allows for another surprising behavior: deception. Males occasionally call in the absence of food (Gyger and Marler 1988). This brings the female close to the male where she can be more easily defended from other males. Experimental data shows that the females stop

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responding if the male calls too often in the absence of food (Evans and Evans, unpublished data). This provides further evidence of the use of long-term memory, eavesdropping and reputation in this social system.

Food calls are also remarkable because they appear to be one of the few animal signals that is not only referential, but also representational; meaning the behavioral response of the listener is mediated specifically by its own information about the event (Evans and Evans 2007). It is as if the signal creates in the receiver a mental representation of an object or event. Significantly, this later capability has only been demonstrated in fowl and a few primate species.

Beyond their sophisticated communication, behavioral flexibility and sensitivity to the attentional state of others, fowl and domestic chickens have also been shown to perform a number of other reputedly cognitively complex capabilities, such as transitive inference and social learning. The ability to infer the relative status of a series of objects or individuals has been suggested to be a measure of logical reasoning ability (Piaget 1928). Hens observing the interactions of a known status individual with an unknown individual are able to infer their own status relative to the unknown individual and to respond appropriately in future interactions (i.e., dominantly or submissively, Beaugrand et al. 1997). Furthermore, chicks tested on an experimental task where series of pairs of items were presented were able to infer the relative rank of each item in new pairs relative to the established hierarchy (Daisley et al. 2009). These results from the social experiments are intriguing because they suggest that the birds may be capable of a mental ‘simulation’ of future interactions based on their indirect experience with an individual. Regardless of the underlying cognitive mechanisms,

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it does appear that the birds are capable of self-assessment and comparisons between themselves and others.

In addition to inferring social relationships, fowl are also able to learn from other individuals in the flock (Nicol 2006). This social learning can be advantageous in an unpredictable environment. It provides the flexibility of individual learning but can reduce the costs associated with attempting a new behavior (e.g., trying a new type of food) through trial-and-error learning. Chicks gain information about palatable food from their mother and she in turn changes her behavior in response to the competency of her chicks. Adults are also capable of learning from other adults and appear to do so more from dominant individuals (perhaps because dominants are more successful in general (i.e., find more food, have more young)) or because the birds monitor the dominant's behavior more closely as described above in the case of food calling). Learning through either imitation, where the individual copies the knowledgeable actor's motions exactly, or emulation, where a novel method is used to obtain the same outcome, are believed to require more complex cognitive processes (Zentall 2003; Whiten et al. 2004) than trial-and-error learning. However, it has proven notoriously difficult to demonstrate conclusively that fowl are using either imitation or emulation when learning from the demonstrator. Nonetheless, it is clear that there is learning.

### **3. The evolution of complex cognition and larger brains**

Brains are energetically expensive, consuming 20% of the daily energy intake of an adult human but accounting for only 2% of the body weight (Moore 2011). It is hence generally expected that animals with larger brains will have higher cognitive faculties than those that are less well endowed. However,

this assumption raises a host of questions. How should brain size be measured? What constitutes higher cognitive skills? What were the selective pressures (environmental, social, or developmental) that lead to enlargement of the brain (known as encephalization)? All of these questions are inter-related and the way in which they are approached affects the conclusions reached about which animals have higher cognitive skills.

#### **4. When it comes to brains, how big is big?**

There have been many different methods used to measure the relative size of animal brains across different taxa (see Healy and Rowe 2007 for review). The most direct method is to compare the ratio of the whole brain volume to the volume expected for its body size. While this method is relatively straightforward and may be useful when comparing within a taxonomic group (e.g., primates), environmental constraints may dictate brain size more than cognitive function when comparing across taxa. For example, bats need to be aerodynamic and lightweight to maintain flight capabilities so their brains are neuronally dense but still relatively small, whereas cetaceans have no such constraint and have a less dense neuronal structure and are larger compared to body size. This method would also not reveal if there were trade-offs in different brain regions that kept the brain volume the same but increased cognitive function. A second approach is to compare the ratio of the volumes of different regions of the brain or of the volume of specific regions to the volume of the whole brain. It is well known that certain regions of the brain perform different functions. The brainstem, which includes the hindbrain and midbrain, primarily controls unconscious functions, such as respiration and blood circulation, as well as postural control and coordinating motor activity. The forebrain, also known as the telencephalon, is associated with higher cognitive functions (e.g., learning, memory, language

(André Parent 2003; Jarvis 2009)). During development, the hindbrain develops first, followed by the forebrain. When comparing different species, the majority of the differences appear in the forebrain. It is speculated that this is because it is easier to modify structures that are still growing later in the development (Finley 2009). Although mammalian and avian brains differ in their architecture, there are structures that are assumed to perform similar functions (Reiner 2005; Herold et al. 2011). Researchers often focus on two parts of the telencephalic section of the brain, the hyperstriatum ventrale and neostriatum in birds and the isocortex (or neocortex) and striatum in primates (Lefebvre et al. 2004). These have been dubbed the “executive” brain. This method of comparing specific parts of the brain may hence be more revealing regarding the evolution of specific regions in response to selective pressures (Reader and Laland 2002; Shultz 2010; Lefebvre et al. 2004). However, a region of the brain may have multiple functions. This confounds efforts to identify specific enlargement of brain areas with increased cognitive abilities (Healy and Rowe 2007). All of the methods used attempt to correlate encephalization with higher cognition as demonstrated by more complex behaviors.

## 5. How to measure higher cognition

Behavioral flexibility has been cited as a key indicator of social intelligence (Jones 2005) and is associated with complex communication (Tomasello 2008). Behavioral flexibility is the ability to deviate from established routines to solve novel problems, including innovation (i.e., novel solutions to environmental or social problems), social learning (the acquisition of information from others), and tool use. A recent study by Reader and Laland (2002) examined the behavioral flexibility of 116 primate species. They found a positive relationship between the rate of innovations and tool use as well as in tool use

and social learning and brain size (as measured by “executive brain” volume ratio to brainstem volume). Similar studies have been conducted to compare the foraging innovation rate of different species of birds with their overall brain size (Overington et al. 2009). Overington et al. (2009) examined reports of different types of novel feeding techniques (such as tool use, feeding from anthropocentric sites, feeding on new food sources) and the number of innovations observed from 803 species in 76 families (phylogenetic groups). As expected, birds with larger brains exhibited more feeding innovations and a higher diversity of innovation types.

## **6. Under pressure: why do animals need to be smarter?**

Several theories have been proposed to explain the evolution of complex behavior and complex cognition. The two dominant theories focus on environmental or social pressures as the drivers of more cognitively complex capabilities. These capabilities in turn require conformational changes in the brain to enable the performance of ever more demanding cognitive tasks.

The ecological hypothesis postulates that complexity or variability in the environment was the driver for more complex cognition; spatial navigation through large territories in search of ephemeral food sources or the need to hunt moving prey required larger brain capacity to meet these demands. This environmental variability should also favor species that are behaviorally flexible and therefore able to use innovative foraging strategies and exhibit other novel behaviors. Evidence to support this hypothesis includes the fact that species with larger brains tend to be better at invading new habitats and exhibit more novel feeding behaviors than smaller brained spe-

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cies (Overington et al. 2011; Lefebvre et al. 1997). Further evidence comes from primate ecology; fruit-eating primates have larger relative brains than leaf-eating primates and species with larger home-range size tend to have larger brains. In addition, fruits are a high-energy food source that may allow the animals that feed upon them to develop larger brains. One potential detractor for this theory is that animals from different taxonomic groups but with similar diets living in the same environment do not all show similar brain enlargement. This suggests that foraging requirements could not be the sole driving force behind brain enlargement and complex cognition (Schultz 2010).

Other researchers have speculated that social structure, including group size, strength of social bonds and complexity of inter-group relationships, should be positively associated with higher cognitive skills (Dunbar and Shultz 2007). There has been some strong evidence that the complexity of the relationships is related to brain size. A loose aggregation of individuals, such as a flock of birds feeding on seeds or insects, probably does not require any difficult negotiations between group members. Individuals stay with the group as long as it is beneficial to them. However, long term connections, either between pairs during parental care, or between multiple individuals of different ranks, may require more long-term memory, the ability to infer third-party relationships (e.g., kin, dominance) and the need to coordinate group activities, such as foraging or group defense (Dunbar and Shultz 2007), as well as a greater ability to communicate about external events in the environment. In addition, group living creates direct competition with other animals for similar resources, such as food, shelter and mates. Individuals that can gain additional resources through manipulation or deceptive tactics will benefit more from group membership. This type of behavior creates pressure on individuals to

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detect and counter deceptive behavior. This leads to a feedback loop of ever more complex behavior as individuals continually innovate and adapt in order to gain the most benefit from group living. The hypothesis that deception and counter-deception lead to higher cognition is known as the Machiavellian intelligence hypothesis (Jolly 1966; Humphrey 1976; Byrne and Whiten 1988).

These two hypotheses are by no means mutually exclusive. It seems likely that a combination of environmental and social factors may have played a role in the evolution of complex cognition.

## **7. Where does this leave the chicken?**

Red Jungle fowl (*Gallus gallus*) are the ancestral form of all domesticated chickens. These ground-dwelling birds evolved in the forests of Indonesia, Ceylon and China. Both males and females have a dominance hierarchy. All groups consist of one dominant male and one dominant female, subordinates of both sexes (up to 12 in the case of females) and juvenile offspring. The average fowl social group consists of six individuals. The dominant male defends a territory and over the course of the day, the group travels around their home range to watering holes and food sources, such as termite mounds and fruiting trees. This daily mobility creates the opportunity for animals to interact with other groups. Group membership is typically stable, however juveniles and subordinate males may move between groups over the course of a season. Chicks are precocial, born able to feed themselves, although they require their mother for thermoregulation and to gain information about food item selection. They gain complete independence from their mother at six weeks of age (McBride et al. 1969).

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Based on the theories put forward to explain the conditions under which higher cognition is predicted to have evolved, fowl exhibit the expected level of cognitive and behavioral abilities. In light of these abilities, chicken brains would be expected to show the same pattern of enlargement of specific regions of the brain as other birds that exhibit such behaviors, like crows. However, most methods of correlating brain characteristics and cognition indicate that fowl should be on the lower end of the cognitive abilities scale. Using the telencephalon ratio method places jungle fowl near the bottom of the list. Of 154 species of bird examined, wild jungle fowl ranked 137<sup>th</sup> (Burish et al. 2004).

There are two possible explanations for why chickens exhibit complex cognitive skills but do not measure up in terms of brain size or brain ratios. The first possibility is that much of what is attributed to complex cognition is actually achieved through associative learning or development of a “rule-of-thumb” based on prior experience. There are several stumbling blocks to this explanation. The first is the use of environmental and social risk factors when aerial alarm calls are produced. The opportunity to learn through observation, particularly during dangerous encounters may be very limited. In the case of alarm calling where one male is put at risk by the behavior of another, it may be more difficult to establish the subtle interactions involved because the outcome may not be immediately clear and attempts to observe the interaction may be confounded by the learning animal’s need to hide during the interaction. This behavioral flexibility, as well as their ability to form transitive inferences and to take into account the attentional state of others, suggests that fowl possess a more sophisticated understanding of their social interactions.

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The second possible explanation is that the size and density of neurons within the brain and the connectivity between the different regions of the brain may be more important in determining cognitive function than the overall brain volume or brain region ratios typically measured. This means that efficiency or connectivity would be more important than simple size (Shultz 2010). Monkeys and apes provide an example of this possibility. There are no systematic differences in the great apes' neocortex ratio compared to that of monkeys' but great apes perform behaviors that suggest that they have more cognitive capabilities. Richard Byrne (1997) proposed that this greater cognitive ability in great apes was achieved by "software adaptations", meaning a reorganization of how information is stored, which did not require structural changes. New research into human brain connectivity, called "connectomes", may yield greater insight into how the interconnectedness of brain regions maps on to brain functions (Joshi et al. 2010).

## 8. Ethical implications

Science cannot answer normative questions; it cannot furnish values to guide ethical decision making. It can however provide facts and theories that describe, explain and predict elements of the workings of the empirical world and can therefore play a role in informing ethical decision making.

The science outlined in this paper challenges common thinking about chickens. Chickens are not mere automata; instead they have been shown to possess sophisticated cognitive abilities. Their communication is not simply reflexive, but is responsive to relevant social and environmental factors. Chickens demonstrate an awareness of themselves as separate from others; can recognize particular individuals and appreciate

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their standing with respect to those individuals; and show an awareness of the attentional states of their fellow fowl. Further, chickens have been shown to engage in reasoning through performing abstract and social transitive inferences. This growing body of scientific data could inform a rethinking about the treatment of these animals.

Broiler or meat chickens are typically housed in 100 meter by 12 meter sheds with between 20,000 and 50,000 animals per shed (Robinson and Hulme 2004). At a maximum stocking density this translates into almost 42 birds per square meter of space. Meat chickens have been selectively bred for fast growth, such that when they are slaughtered at 6 weeks of age (the age at which a wild chicken would just become independent from its mother), these birds weigh more than their adult wild counterparts. Research has also shown that because of their exceptionally high rate of growth and weight gain there is a high potential for leg fractures, foot problems, heart failure and other serious conditions, such as obesity, prior to slaughter. In order to prevent these problems, young broiler birds must be kept on a severely calorically restricted diet, which means they suffer from extreme hunger (Duncan 2010). Male chickens hatched in the egg-laying and meat industry production are killed on the day they hatch by maceration because they are unsuitable for either industry.

The facts surrounding the housing of hens in the egg-laying industry are similar to those in the meat industry. Approximately 90% of the commercial eggs laid are in “cage” systems. In the conventional cage system, each bird gets 400 cm<sup>2</sup> of unrestricted floor space but no nest boxes, litter for foraging or dust bathing or perches (CSIRO 2002). High stocking density and the lack of environmental enrichment leads to aberrant behav-

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ior, such as feather pecking and cannibalism. In response to these problems, the beaks of the birds are routinely trimmed using hot blades or lasers. These procedures can lead to chronic pain for the life of the bird. The European Union has banned unenriched cages as of January 1, 2012 and will require at least 600 cm<sup>2</sup> of cage area per hen (European Union Directive 1999/74/EC). As consumers become more aware of the facts regarding these intensive farming systems, other housing systems, such as “barn-laid” and “free-range” systems for egg production are becoming more popular. This change in buying behavior based on a perception of improved animal welfare suggests a change in the public’s attitude towards the treatment of farmed animals.

Intensive farming practices have made chickens cheaper and more readily available for human consumption. However these intensive production systems cause some birds to have chronic pain; others to have their legs break under their own weight or to be attacked or killed by their cage mates. If, as some philosophers have argued, moral standing is grounded in the possession of such capacities as communication, awareness and rationality, then we have provided evidence that suggests chickens merit at least some moral consideration. And if they do, then the physical, social and psychological harms routinely inflicted on them through their use in meat and egg production are made problematic.

Scientific research into animal welfare can inform changes in the intensive farming systems that may reduce the likelihood of these physiologically adverse events. However, as suggested by Bryant (2007) and others, there is a significant tension at play here. In order to establish that nonhuman animals have ethical worth grounded in their possession of certain capacities

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and to understand what constitutes good practice toward them, scientific experimentation is required, yet experimentation on nonhuman animals is in itself ethically problematic. In the case of chickens, much of what is known about their capabilities has been learned through captive studies, since fowl, like most species, are cryptic in the wild. It is very difficult to track individuals and to record their social interactions. Although observations of animals in the wild provide the basis of our understanding of natural behavior, these natural settings limit the types of experiments possible and level of experimental control. This may therefore reduce the strength of conclusions that can be drawn.

Whenever captive animals are used in research in Australia and many other similar jurisdictions, the scientists must adhere to the 3Rs. These require, where possible, the Replacement of animals in research, Reduction in the number of animals used and Refinement of techniques and technologies used in order to minimize pain and suffering and to avoid “death as an endpoint” (i.e., euthanasia at the completion of the experiment). A notable feature of the experimental work with chickens is the extent to which these researchers have rigorously applied the 3Rs and in fact gone beyond these principles. For example, live chickens have been replaced with 3D animated animals in some experiments. This refinement of the experimental method enables behavioral and physical characteristics to be manipulated on an animated virtual bird without harming a live one. Birds react naturally to the animation and the animation provides precise control over the virtual bird’s actions (Smith et al. 2009). This also reduces the number of birds that need to be held in captivity since the animation can be changed to suit each new experiment.

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Furthermore, those who do research with chickens have begun to pursue a new interpretation of the 3<sup>rd</sup> R (Refinement). Because chickens have a fast reproductive cycle new animals *can* be sourced on a constant basis, nonetheless researchers go to great lengths to avoid “death as an end-point” for their study subjects. This new approach involves Retiring experimental animals to places outside of the research realm. Researchers frequently find good homes for their animals, including adopting out the birds to chicken fanciers (people who raise and show them at competitions or simply keep them as pets), or donating them to zoos for exhibition. Though the suggestion of re-homing experimental animals might seem far-fetched, this principle has been raised in recent public consultations on revisions to the “Australian Code for the Care and Use of Animals for Scientific Purposes” (National Health and Medical Research Council 2011, section 3.9.3).

## 9. Conclusion

In this paper we have shown that recent experimental work with chickens demonstrates they are much more cognitively complex than previously thought. We have explained how this research demonstrates the difficulty in measuring cognitive abilities and the ongoing challenge of linking cognitive function to brain architecture. We have also discussed how those who do research with chickens go beyond what is mandated by the current “Code of Practice” and frequently re-home their experimental animals. We maintain that the re-homing of experimental animals could profitably be explored in other behavioral research settings and recognize that some researchers on other species have also taken the initiative in this area. Finally, although there is the question whether the ethical treatment of an animal should be tied to its cognitive ability, we think that the research we have discussed may provide a new perspective

for the public on the manner in which chickens are raised and routinely killed to suit human dietary desires.

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