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Individual recognition based on communication behaviour of male fowl

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ABSTRACT

Correctly directing social behaviour towards a specific individual requires an ability to discriminate between conspecifics. The mechanisms of individual recognition include phenotype matching and familiarity-based recognition. Communication-based recognition is a subset of familiarity-based recognition wherein the classification is based on behavioural or distinctive signalling properties. Male fowl (*Gallus gallus*) produce a visual display (tidbitting) upon finding food in the presence of a female. Females typically approach displaying males. However, males may tidbit without food. We used the distinctiveness of the visual display and the unreliability of some males to test for communication-based recognition in female fowl. We manipulated the prior experience of the hens with the males to create two classes of males: S^+ wherein the tidbitting signal was paired with a food reward to the female, and S^- wherein the tidbitting signal occurred without food reward. We then conducted a sequential discrimination test with hens using a live video feed of a familiar male. The results of the discrimination tests revealed that hens discriminated between categories of males based on their signalling behaviour. These results suggest that fowl possess a communication-based recognition system. This is the first demonstration of live-to-video transfer of recognition in any species of bird.

1. Introduction

The establishment and maintenance of long-term relationships requires not only sensitivity to identity-specific information but also the cognitive ability to build a representation of identity. The animal must be able to store that representation with information about previous interactions and be able to retrieve it when confronted with a similar situation in order to guide behaviour towards that specific individual in the future (Sherman et al., 1997). This type of social recognition can be accomplished through several mechanisms, including phenotype matching and familiarity (Bradbury and Vehrencamp, 1998). With phenotypic matching, the individual compares the other's external characteristics, which have been shaped by genetic inheritance and the environment (e.g. appearance, odors and/or behaviours), with its own or with that of another known individual of a specific social class (e.g. family member). Familiarity-based recognition, on the other hand, is thought to require direct observations or interactions with that specific individual to gain knowledge of its particular features. This individual is then classed with other animals in that social category. With these two mechanisms, learning and memory play a central role since the individual must develop an internal model, which likely includes behavioural and morphological characteristics, based on experience with the signaler (Bee, 2006).

A subset of familiarity-based recognition is communication-based recognition, wherein the categorization is based on the individual's signalling behaviour. Although communication-based recognition may confer some benefit by enabling the receiver to avoid individuals where previous interactions have been costly (e.g. deceptive signals or aggressive interactions; Smuts et al., 1987) and preferentially direct assistance to kin or allies (Hamilton, 1964), communication-based recognition is not essential for many types of social interactions, including parental care, kin selection or mate choice (Mateo, 2004). Furthermore, multiple types of recognition systems may exist simultaneously in a species (Bee, 2006). Hence a communication-based recognition system cannot be assumed to be absent or present in a species unless it had been empirically tested (Sherman et al., 1997; Tibbetts and Dale 2007).

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To test for communication-based recognition in a nonhuman species, subjects need to be presented with ecologically valid stimuli. The use of video images may facilitate these types of studies by enabling test subject to observe the physical characteristics as well as the communicative repertoire of the individual that is to be recognized (Bee, 2006). Video images also allow the experimenter to present each sensory channel (e.g. visual, auditory, vibrational) separately (Smith and Evans, 2013) and to select the behaviours seen by the test subject (Van Dyk and Evans, 2007). Presentation of video images has been used successfully in behavioural research with numerous species (e.g. pigeons: Partan et al., 2005; zebra finches: Galoch and Bischof, 2007; chickens: Smith and Evans, 2008; dogs: Pongrácz et al., 2003; chimpanzees: Hooper et al., 2012) and in studies of individual recognition (e.g. fish: Balshine-Earn and Lotem, 1998; birds: Bird and Emery, 2008).

The focus of the current study is fowl (*Gallus gallus*), a well-studied species that possess complex communication systems (Collias and Joos, 1953; Evans and Evans, 1999, 2007) and lives within a hierarchical social structure (McBride et al., 1969). Previous studies of jungle fowl and domestic strains have almost exclusively focused on social recognition using physical characteristics, including visual, auditory or olfactory cues (e.g. Vallortigara, 1992; Regolin et al., 2012). These studies have presented cues in isolation and in combination, typically using live conspecifics, photographs or modification of imprinted objects (Dawkins, 1995; D'Eath and Keeling, 2003; Porter et al., 2006; Abeyesinghe et al., 2009). The results of these studies have indicated that hens can discriminate between familiar and unfamiliar individuals (D'Eath and Keeling, 2003; Porter et al., 2006; Abeyesinghe et al., 2009), although no attempt has been made to determine whether the preference for familiar stimuli is a specific social behaviour or if it reflects a more general neophobic response. Previous research also suggests that altering morphological characteristics, such as the comb, wattle or feather patterns, decreases perceived familiarity with previously encountered females and males (Guhl and Ortman, 1953; Marks et al., 1960; Candland, 1969) and that vocalizations may also facilitate recognition of familiar individuals by chicks (Evans and Mattson, 1972).

Taken together, these studies suggest that fowl are capable of phenotype matching, based on morphological characteristics, and familiarity recognition. They indicate that chickens are sensitive to individual variation among conspecifics and can remember previously encountered conspecifics. However, an outstanding question is whether this species is capable of communication-based recognition (i.e. can use behavioural characteristics combined with morphological differences to achieve recognition).

Male jungle fowl produce a wide range of visual, auditory and multimodal (combined visual and auditory) signals (Collias and Joos, 1953; Davis and Domm, 1943). For this study, we used the males' performance of the multimodal food-related signal known as tidbitting. This distinctive display combines repeated rhythmic movements of the head and neck with pulsatile vocalizations and is performed by males upon finding food in the presence of a hen (Davis and Domm, 1943). The two signals can be performed independently (Smith et al., 2012) and females respond similarly to each signal (Smith and Evans, 2008, 2009). Females can also discriminate between the same male tidbitting and other similar food-related movements (Smith et al., 2011). Females typically respond to tidbitting signals by approaching and food searching near signalling males (Davis and Domm, 1943). Hens spend longer oriented towards and remain in closer proximity to signalling males than to non-signalling males (Smith and Evans, 2009).

Males vary substantially in the reliability of their tidbitting behaviour. Up to 45% of some male's signals are performed in the absence of food (range: 33–67%; Gyger and Marler, 1988). The honesty of a male's signal is positively correlated with his dominance rank (Pizzari, 2003) and negatively correlated with his distance to the female (Gyger and Marler, 1988). Male condition, which is correlated with rank, may also affect male honesty (Pizzari, 2003). For females, approaching these functionally deceptive males presents several potential costs including lost foraging opportunities and greater exposure to predators by approaching a vocalizing male. Several factors have been identified as affecting the likelihood of a female approaching a tidbitting male. Females are more likely to approach dominant males compared to subordinate males (Pizzari, 2003) and more likely to approach the same male if the current display is honest (Gyger and Marler, 1988). Female distance to the male is also negatively correlated with the likelihood of the female approaching (Smith et al., 2012). It is hence difficult to disentangle the factors of distance, male condition and honesty in determining female response to male behaviour.

In this study, we used a combination of live training and a live video feed to determine if hens were capable of discriminating between equally familiar individuals based on their signalling behaviour. Previous research has demonstrated that hens respond with natural behaviours to video playbacks of conspecifics (Evans and Marler, 1991; Smith and Evans, 2008), which suggests that a live video feed should elicit similarly appropriate behavioural responses. We used a discrimination experiment in which male tidbitting reliability was manipulated while standardizing factors such as rank, attractiveness and distance to the displaying male. If chickens possess a communication-based recognition system, then females should be able to learn and recall specific information about each male's tidbitting reliability and this should alter her response to the specific male's tidbitting display.

2. Methods

2.1. Subjects

We used 36 (1:1 sex ratio) golden Sebright bantam fowl for these experiments. All birds were housed in 1.0 × 1.0 × 0.6 m cages with ad libitum access to food (Gordon Specialty Feeds laying ration, Sydney, Australia) and water in a climate-controlled room maintained at 22 °C on a 12:12 h light:dark cycle. The cages were arranged in a rectangular configuration such that each female was housed adjacent to two males. The distance between each cage was 8 cm to allow the females to visually inspect the males (Guhl and Ortman, 1953). Previous research suggests that visual recognition can be accomplished when individuals approach conspecifics to within 30 cm (Dawkins, 1995, 1996; Dawkins and Woodington, 1997). Within this distance, hens typically use the frontal binocular field to view conspecifics (Dawkins, 2002).

2.2. Ethical note

The protocols used in this experiment were conducted in accordance with the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (NHMRC, 1997). All procedures were approved under Macquarie University AEC protocol 2009/057.

3. Experimental design

3.1. Familiarizing hens with males' tidbitting behaviour

To create two males that were equally familiar to the test female but differed in their tidbitting honesty, we randomly designated one of the males adjacent to each female as the 'rewarding' (S+) male and the other as 'nonrewarding' (S−). The S+ male was paired with a food reward and the S− was not, such that when the S+