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Variation in proactive - reactive personality types in the red junglefowl

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It has been shown in many species that individuals exhibit consistent differences in behaviour over time and/or across situations. These differences in behaviour are called personality. One way to categorise personality types typically used for rodents, is along a proactive-reactive gradient, which describes how individuals cope with stressful challenges. Proactive individuals pay less attention to their environment, form routines easily and take longer to adapt when routines are broken compared to reactive individuals. Avian species have to date rarely been described along this gradient, thus the generality of this description across species is unclear. The present study has investigated variation in proactivity-reactivity in red junglefowl chicks (*Gallus gallus*). To observe the chicks' coping styles, a proactive-reactive test was conducted where the chicks were trained to form a routine, which was then broken. Their behavioural response to this was recorded and used as a measure for proactivity-reactivity. The behavioural response was then linked to individual behavioural variation in additional personality assays. Individuals that were more vigilant in the proactive-reactive test often uttered stress calls and took longer to complete the test. In contrast, individuals that walked more and did not utter stress calls had a shorter time to complete the test. These findings can be used to describe proactive red junglefowl chicks; those that are more stressed when routines are broken, compared to calmer reactive individuals. I found no difference in routine formation between proactive and reactive red junglefowl chicks, suggesting that what describes proactive and reactive individuals may vary across species.

Nyckelord/Keyword:

Behaviour, chicken, coping style, *Gallus gallus*, personality

Table of contents

| | | |
|-----|---|----|
| 1 | Abstract | 2 |
| 2 | Introduction..... | 2 |
| 3 | Material and methods..... | 5 |
| 3.1 | Animals and housing..... | 5 |
| 3.2 | Association and reversal learning test..... | 5 |
| 3.3 | Novel arena and novel object tests..... | 7 |
| 3.4 | Proactive-reactive test | 9 |
| 3.5 | Statistical analysis | 12 |
| 4 | Results | 12 |
| 4.1 | Proactive-reactive test | 12 |
| 4.2 | Comparison of responses obtained in the proactive-reactive test, novel arena and novel object tests | 15 |
| 4.3 | Comparison of responses obtained in the proactive-reactive test and association and reversal learning test | 17 |
| 5 | Discussion | 17 |
| 5.1 | Conclusion..... | 20 |
| 6 | Acknowledgements..... | 20 |
| 7 | References | 21 |

1 Abstract

It has been shown in many species that individuals exhibit consistent differences in behaviour over time and/or across situations. These differences in behaviour are called personality. One way to categorise personality types typically used for rodents, is along a proactive-reactive gradient, which describes how individuals cope with stressful challenges. Proactive individuals pay less attention to their environment, form routines easily and take longer to adapt when routines are broken compared to reactive individuals. Avian species have to date rarely been described along this gradient, thus the generality of this description across species is unclear. The present study has investigated variation in proactivity-reactivity in red junglefowl chicks (*Gallus gallus*). To observe the chicks' coping styles, a proactive-reactive test was conducted where the chicks were trained to form a routine, which was then broken. Their behavioural response to this was recorded and used as a measure for proactivity-reactivity. The behavioural response was then linked to individual behavioural variation in additional personality assays. Individuals that were more vigilant in the proactive-reactive test often uttered stress calls and took longer to complete the test. In contrast, individuals that walked more and did not utter stress calls had a shorter time to complete the test. These findings can be used to describe proactive red junglefowl chicks; those that are more stressed when routines are broken, compared to calmer reactive individuals. I found no difference in routine formation between proactive and reactive red junglefowl chicks, suggesting that what describes proactive and reactive individuals may vary across species.

2 Introduction

People differ consistently in their tendencies to be anxious, aggressive, social, active and curious (Gosling & John 1999). These differences in behaviour are called personality in humans (Gosling & John 1999). It has now been shown that many non-human species also exhibit these consistent differences in behaviour (Gosling 2001). Such consistent differences have been seen in aggressiveness (Riechert & Hedrick 1993), fearfulness (Boissy 1995), exploration (Dingemanse et al. 2002), risk-taking (Fraser et al. 2001) and activity (Sih et al. 2003) in a variety of species. However, it is not fully understood why personality exists. The traditional view was that all individuals could perform optimal behaviour in all situations (Sih et al. 2004). Nevertheless, individual behaviour is obviously constrained somehow to give rise to these observed personality traits. One theory is that these differences in behaviour are non-adaptive variation surrounding adaptive averages (Dall et al. 2004). But, variation

in behaviour between individuals is often distributed non-randomly, following specific patterns (Gosling & John 1999, Gosling 2001). This non-random distribution suggests that the variation in behaviour between individuals have evolutionary consequences and is under selection (Dall et al. 2004). Another theory aiming to explain the evolution of personality, is that personality exists because behavioural flexibility might not always be beneficial (Dall et al. 2004). In an environment that changes continuously, such that a behaviourally flexible individual cannot predict it accurately, it is likely that the behavioural flexibility induce costs in terms of longer time to respond rather than benefits, compared to a less flexible individual (Dall et al. 2004). In this scenario, individuals may show less flexible responses, and these responses may differ between individuals.

Regardless of its evolutionary origin it is clear that the observation of animal personality alters the way we think about adaptive behaviours. The fact that these differences in behaviour exist indicate that there may be underlying trade-offs explaining variation in personality types. Different personality types might have a fitness advantage in different situations, but in the long perspective the fitness of individuals may be the same. For example, when considering a foraging context, an individual that is bold when gathering food might do well when food and predators are scarce. Meanwhile, an individual that is more careful when gathering food might do better than the bold individual if food and predators are abundant. Since personality is consistent some researchers suggest that instead of looking at behaviours in isolated contexts, they should be studied across different situations for a more holistic view (Sih et al. 2004). A behaviour that appears suboptimal when viewed in a single situation could prove adaptive when viewed across situations (Sih et al. 2004).

One way to categorize personality types is along a proactive-reactive gradient, which has been done in some vertebrate species, mainly laboratory rodents (Koolhaas et al. 1999). Proactive and reactive personality types describe how an individual copes with different situations, particularly stressful situations. Coping can be defined as the physiological and behavioural efforts to master the situation (Koolhaas et al. 1999). Failure to cope with a situation can lead to increased stress levels, decreased body weight and death as the ultimate consequence (Wechsler 1995). Proactive individuals are typically described as fast-exploring and bold, higher in aggression and routine formation, but with lower behavioural flexibility. Reactive individuals on the other hand are often described as thorough-exploring and cautious, having lower

aggression and routine formation, but higher behavioural flexibility (Koolhaas et al. 1999, Coppens et al. 2010, Quinn et al. 2011). Proactive individuals seem to be more rigid and internally driven in their behaviour compared to reactive individuals who are more sensitive to their environment and changes to it (Coppens et al. 2010). This means that proactive individuals that form routines faster should have a harder time adapting if the routines no longer can be carried out. Reactive individuals that form routines more slowly should on the other hand have an easier time adapting to changes in the environment since they are more flexible. For example, reactive individuals are typically better at reversed learning tests where a behaviour is first rewarded and then no longer rewarded, compared to proactive individuals (Coppens et al. 2010, Titulaer et al. 2012). These predictions are so far poorly investigated in other species but rodents, and in avian species particularly (but see Titulaer et al. 2012).

The current study aims to examine variation along the proactive-reactive gradient of in red junglefowl chicks, *Gallus gallus*. The red junglefowl is the wild ancestor to all domestic fowl (*Gallus gallus domesticus*, Fumihito et al. 1994). In addition to obtaining information on personality in a wild species, the use of red junglefowl may therefore potentially be applied also to the poultry industry. Especially interesting are indications that link a proactive personality type to feather pecking (Jensen et al. 2005). Feather pecking is a behaviour where a bird pecks at and sometimes pulls out feathers from another bird. This behaviour can lead to severe injuries and death of the beset individual. By better understanding the trade-offs between a proactive or reactive personality type more informed decisions can be made regarding how to breed poultry. For example, breeding poultry that exhibits a more reactive personality type could potentially improve poultry welfare.

The overall aim of the project was to investigate variation in proactivity-reactivity in red junglefowl chicks to further our understanding of variation in personality. This was accomplished by first examining the relationship between speed of routine building and flexibility in behaviour when the routine cannot be successfully performed. Secondly, this relationship was linked to variation within individuals in their behavioural responses in additional personality assays.

3 Material and methods

3.1 Animals and housing

This study used 56 (27 females, 29 males) red junglefowl chicks from two batches of eggs hatched and kept at Linköping University (Department of Physics, Chemistry and Biology, Zoology).

There were a total of 37 chicks in batch 1 of which 23 were tested. In batch 2 there were a total of 64 chicks of which 33 were tested (the non-tested individuals were acting as non-handled controls for a parallel experiment). All individuals were marked after hatching with wing-tags with unique identity numbers to facilitate individual recognition. The chicks were housed in mixed-sex groups in a room with mixed poultry in separate enclosures measuring 0.5-3.0 m². The room kept a temperature of about 28° C. The chicks had free access to commercial poultry feed and water. The floor of the cage was covered with wood shavings and when the chicks reached an age of about 2 weeks they were provided with perches.

The chicks were exposed to a series of cognitive and personality tests between 22nd of March and 23rd of May 2013 as part of a larger project. All tests tested the chicks individually. The first test the chicks were exposed to was an association and reversal learning test which was conducted when the chicks were 2-6 days old. The second test was a generalisation test which was conducted when the chicks were 12-17 days old. The third test was a novel arena and novel object test which was conducted when the chicks were 28-29 days old. The last test was a proactive-reactive test which was conducted when the chicks were 30-34 days old. The first test took place in a room adjacent to where the chicks were housed to avoid stressful transportation during the chicks' first days. The temperature in the room was about 26° C. Test 2-4 took place in a more spacious lab, situated in another building, approximately 300 meters from the building where the chicks were housed. The temperature in the lab was about 26° C and the chicks were housed in cages with a size of 72x70x60 cm (LxWxH). The cage floor was covered with wood shavings and the chicks had free access to commercial poultry feed, water and perches.

3.2 Association and reversal learning test

To test the chicks' ability to associate a colour with a food reward half of the chicks were assigned to a blue colour treatment and half were assigned to a green colour treatment. The chicks were trained to associate their assigned colour with a food reward. Training took place in an arena

with the size 37x28x18 cm (LxWxH). The arena was a mesh container covered with cardboard without a roof. The far end of the arena was separated down the middle by a cardboard wall (Figure 1) to reduce ambiguities regarding which side of the arena the chick was on (i.e. the choice a chick made, see below). One green and one blue food bowl was placed in the far end of the arena, one on either side of the wall. Behind each food bowl a paper square with the same colour as the bowl was placed to help the chicks see the colour.

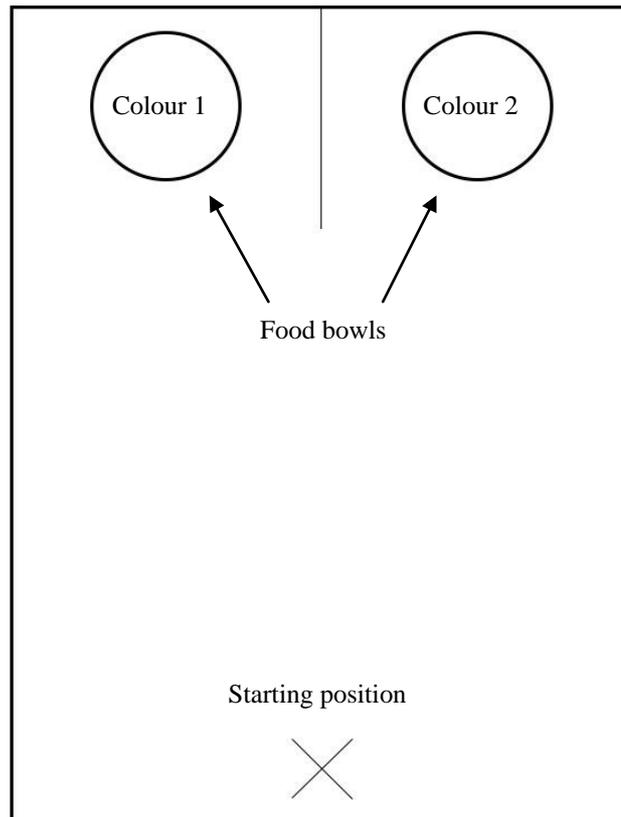


Figure 1. The association and reversal learning test arena the red junglefowl chicks were tested in. Size of the arena was 37x28x18 cm (LxWxH).

At the beginning of each association trial a meal worm was placed in the bowl the colour the chick had been assigned, as a reward. The chick was placed at the end opposite the food bowls. The chick was encouraged to go to the correct food bowl by the trainer until it started to investigate the bowls on its own. Each time the chick had eaten the meal worm it was taken out of the arena and placed in a compartment next to it. The bowls were switched around every trial so the chick would not associate left or right with the food reward. Each time the chick ate a meal worm it was counted as one association made between the assigned colour and the food reward. The total number of associations required for the chick to

learn which colour was rewarded was recorded. The chick was considered to have learned its rewarded colour when it chose the assigned colour 5 times in a row without inspecting the unrewarded colour.

To test the chicks' behavioural flexibility a reversal learning test was done. After the chick had learned which colour was rewarded, that colour stopped being rewarded and the previously unrewarded colour started to be rewarded. As a measure of the chick's behavioural flexibility it was recorded how many associations (i.e. number of meal worms eaten from the bowl that now was rewarded) it took for the chick to learn that the new colour was rewarded. Additionally, during the first trial after the rewarded colour had been switched it was measured how long it took for the chick to inspect the previously unrewarded colour. This can be seen as a measure of the response an individual had to a previously formed routine, being broken.

3.3 Novel arena and novel object tests

To test other aspects of the chicks' personality, novel arena and novel object tests were carried out. Two chicks were tested simultaneously, but individually in separate arenas situated next to each other. The test arena was of plywood with a mesh roof and measured 114x76x40 cm (LxWxH). The floor was rubber mats partly covered with wood shavings. A feed bell and a water bell were placed in the arena so the chick could not see the entire arena from its starting position (Figure 2). Obstructing the chick's view of the arena should encourage explorative behaviour. With the room almost completely dark, to discourage the chicks from moving, the two chicks were simultaneously placed on the floor in a corner of their individual arenas (Figure 2). The two observers then moved to a position behind a screen, out of sight from the chicks to avoid the chicks being influenced by the observers during testing. The lights were turned on and the chicks were monitored on two screens displaying live feeds from two cameras. The chicks were monitored for 10 minutes starting when the lights were turned back on. Behaviours were recorded using instantaneous registration with 10 seconds intervals for 10 minutes (Table 1). Additionally, 'latency to move' (both feet), 'latency to explore all areas', 'latency to vocalise' and the 'total number of escape attempts', were recorded. The novel arena was divided in 6 imaginary squares, each measuring 38x38 cm (Figure 2). The 'activity' of the chick was continuously recorded as number of movements across these 6 sub-areas of the arena. Each time the chick entered a new square it was recorded as a movement.

After 10 minutes had passed, the lights were turned off again and the novel object was placed on the arena floor in the corner farthest from the chick. The novel object was a roughly spherical soft toy, approximately 10 cm in diameter, coloured orange and brown with big yellow eyes. The observers retreated back behind the screen, the lights were turned back on and the chicks were monitored for another 10 minutes. The same parameters as in the novel arena test were registered in the novel object test (Table 1, and above). Additionally, 'latency to interact with the novel object', was registered.

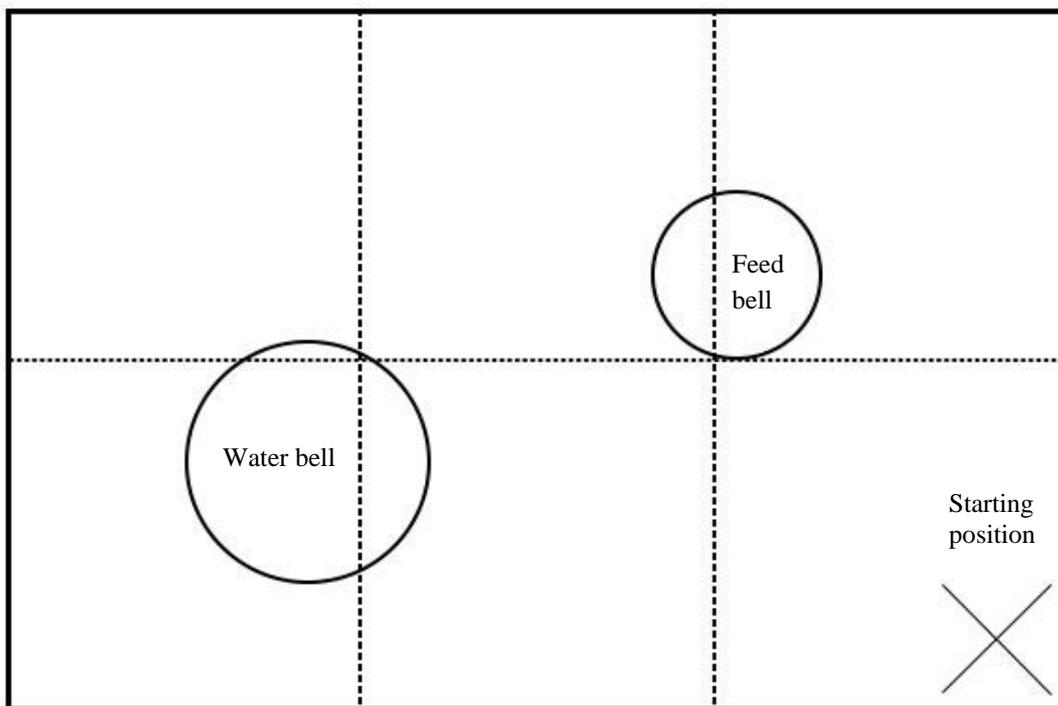


Figure 2. The novel arena test and novel object test the red junglefowl chicks were exposed to. The cross (X) marks the position where the chick was placed at the start of the test. Dotted lines show the 6 imaginary squares used to record movement.

Table 1. Behaviours of red junglefowl chicks recorded during the novel arena and novel object tests.

| <i>Behaviour</i> | <i>Definition</i> |
|-------------------------|---|
| Stand | Standing still, head in neutral position possibly looking around. Stomach not touching ground. |
| Walk | Moving forward, head in neutral position moving back and forth in time with the gait. |
| Run | Fast locomotion, wings often flapping. |
| Freeze | Standing absolutely still and not moving any part of the body. |
| Vigilance | Standing still or moving forward while looking around with stretched neck. Posture is more erect than during walking. |
| Head down | Standing still and looking at the ground, head held lower than while standing. |
| Peck | In the process of knocking at something with the beak. |
| Preen | Manipulating its plumage with the beak. |
| Lie down | Lying down, legs bent and stomach touching ground. This behaviour takes precedence over head down, peck and preen. |
| Escape | Jumps toward mesh roof. |
| Stress call | High pitch peeping. |
| Other | Behaviours not defined above. |

3.4 Proactive-reactive test

To test the chicks' coping style a proactive-reactive test was conducted. The chicks were trained to perform a routine to get a food reward (meal worm). All training sessions continued for as long as the chick showed interest for the food reward and was willing to work for it. If a training session was ended before any routine had been formed, a new training session commenced after approximately an hour. All individual chicks were trained and tested on the same day. After the chicks had learned the routine and the routine was considered to be stable, the chicks were prevented from performing the set routine and their behaviour and flexibility were scored.

The routine consisted of the chicks running through a test arena with a bowl of meal worms at the end (Figure 3). The test arena was very similar to the one used in the novel arena test which the chicks had done previously. This similarity should reduce the effects of fear of a novel environment on the training process. The test arena was built out of plywood with a mesh roof and measured 114x76x40 cm (LxWxH). The floor was rubber mats partly covered with wood shavings. The arena was divided in the middle by a plywood wall running lengthwise leaving an opening at the start and the end of the arena. The opening at the start acted as a shortcut to the food reward and was blocked by mesh during training (Figure 3, left side). At the beginning of the test arena there was a starting box where the chicks were placed. The chicks could not see the food reward from their starting position.

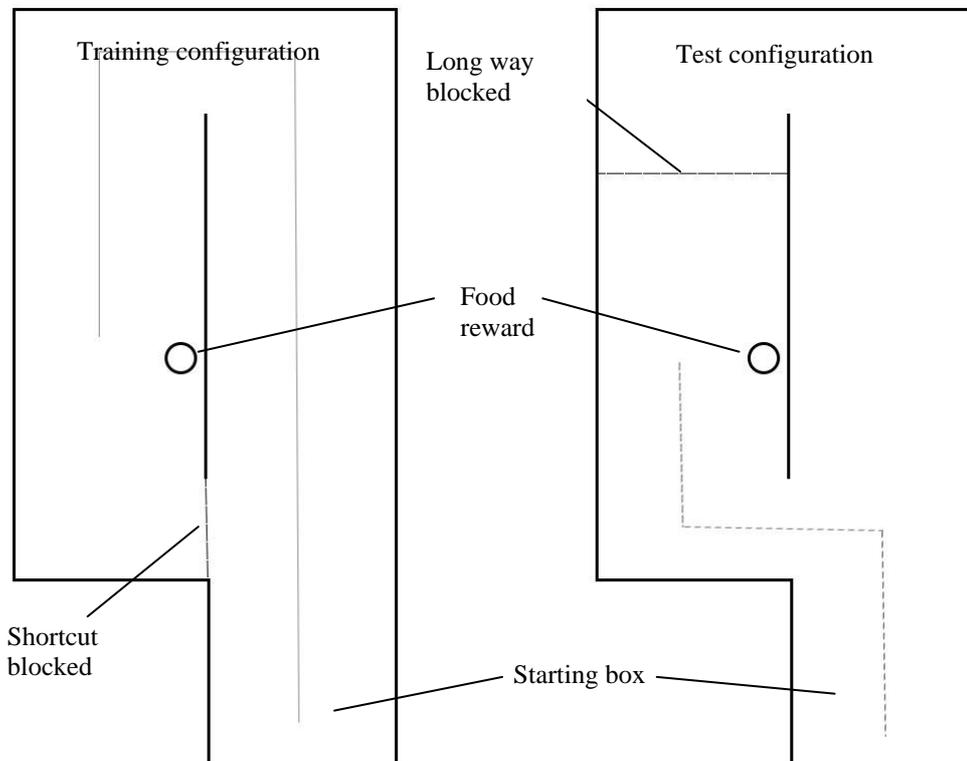


Figure 3. The two configurations of the proactive-reactive test arena the red junglefowl chicks were tested in. Left side shows the training configuration and right side shows the test configuration. Grey line shows the suggested route the chick should take to get to the reward.

During the first part of the training the chicks were encouraged by the trainer to run the long way through the arena to the food reward. After the chicks started to learn the routine they were released in the starting box and the trainer stepped out of sight behind a screen to avoid influencing the chicks' behaviour in the arena. During this second part of the training the chicks were monitored on two screens displaying live feeds from two

cameras. The chicks were trained until they performed the routine 5 times in a row without encouragement from a trainer, hesitation or showing any exploratory behaviour. The number of times the chicks had to be trained to learn the routine was recorded to measure speed of routine formation. After the chicks had performed the routine 5 times in a row the path the chicks had been trained to use was blocked and the shortcut was opened (Figure 3, right side). The blockage was out of sight from the starting position and made out of mesh so the chicks could see the food bowl. The chicks were released in the starting box and monitored with the cameras. Their movement in the test arena, behaviour and time to complete the test (to find and eat the food reward), were recorded. Movement was recorded continuously using an imaginary grid pattern and was a measure of how many transitions an individual made between these sub-areas (Figure 4). Behaviour was recorded instantaneously every 10 seconds. The behaviours recorded were walk, vigilance and other (Table 2). Additionally the ‘latency to the first stress call’ was recorded (Table 2). If the chicks did not find the food reward by using the shortcut in 10 minutes, the test was ended and the chick was given maximum time to complete the test (600 s).

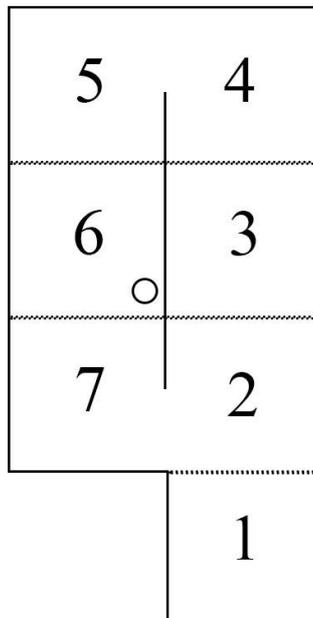


Figure 4. The imaginary grid map used for recording the red junglefowl chicks' activity (when borders were crossed) in the test arena.

Table 2. Behaviours of red junglefowl chicks recorded during the proactive-reactive test.

| <i>Behaviour</i> | <i>Definition</i> |
|-------------------------|---|
| Walk | Moving forward, head in neutral position moving back and forth in time with the gait. |
| Vigilance | Standing still or moving forward while looking around with stretched neck. Posture is more erect than during walking. |
| Stress Call | High pitch peeping. |
| Other | Behaviours not defined above. |

3.5 Statistical analysis

The behaviours that were recorded throughout the novel arena, novel object test and proactive-reactive test were converted so they expressed how much of the test time the behaviour was exhibited (by dividing the number of times a behaviour was recorded, over the time an individual was in the test arena). The behaviours ‘head down’, ‘peck’, ‘preen’ and ‘lie down’ exhibited in the novel arena and novel object tests were converted to a single variable named ‘calm’. Continuous data were compared using Spearman rank order correlations (due to non-normally distributed data). The effects of categorical data were compared using Mann-Whitney U test.

All analyses were conducted in StatSoft’s Statistica.

4 Results

4.1 Proactive-reactive test

In the proactive-reactive test, walking was strongly negatively correlated with vigilance ($R_s = -0.94$, $p < 0.05$, Figure 5). I will therefore primarily show relationship between vigilance and responses from other tests in the following results, because these two behaviours are the mirror opposites of each other.

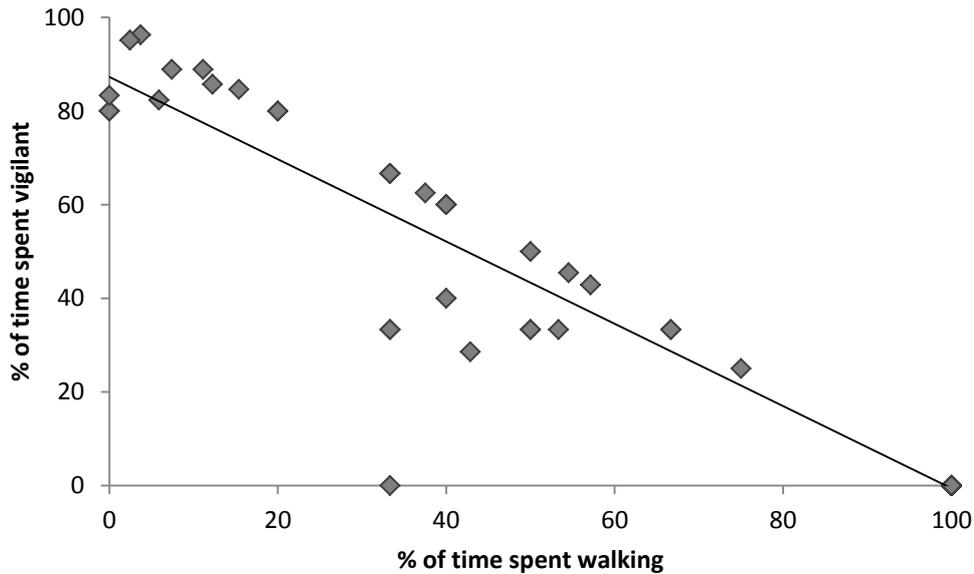


Figure 5. In the proactive-reactive test, individual red junglefowl chicks that spent more time walking spent little time being vigilant, and vice versa.

The amount of time an individual spent being vigilant was positively correlated with the time it took an individual to complete the proactive-reactive test ($R_s = 0.85$, $p < 0.05$). Individuals who uttered stress calls in this test, spent more time being vigilant compared to individuals who did not utter stress calls (Figure 6). In contrast, individuals who did not utter stress calls spent the entire time walking (Figure 6). Individuals who uttered stress calls also took longer time to complete the proactive-reactive test compared to individuals who did not utter stress calls (Figure 7). Due to this clear grouping of the data, some further analyses are conducted using the categorisation ‘uttered stress calls’ and ‘did not utter stress calls’.

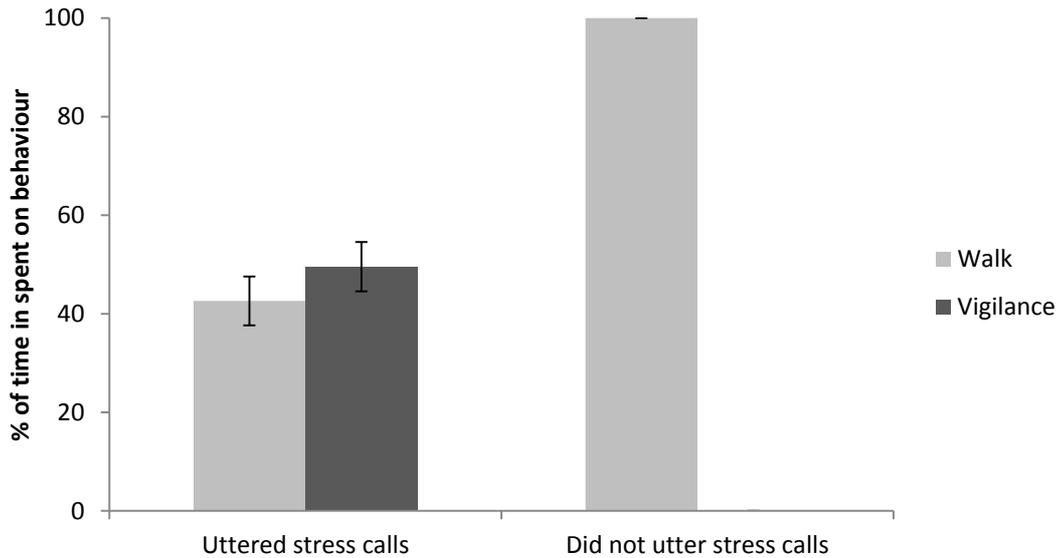


Figure 6. Individual red junglefowl chicks that uttered stress calls spent more time being vigilant, compared to individuals that did not utter stress calls, in the proactive-reactive test (mean \pm SE, 'uttered stress calls': $49.6 \pm 5.0\%$, 'did not utter stress calls': $0.0 \pm 0.0\%$, $p < 0.05$). Individuals who did not utter stress calls spent their entire time walking (mean \pm SE, 'uttered stress calls': $42.6 \pm 5.0\%$, 'did not utter stress calls': $100.0 \pm 0.0\%$, $p < 0.05$).

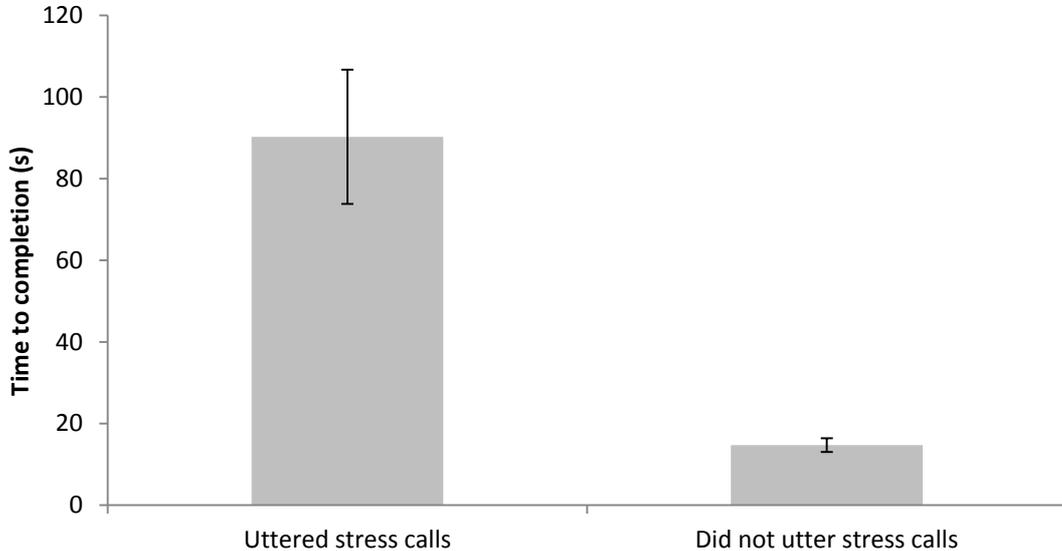


Figure 7. Individual red junglefowl chicks that uttered stress calls took longer time to complete the proactive-reactive test, compared to individuals that did not utter stress calls (mean \pm SE, 'uttered stress calls': 90.3 ± 16.4 s, 'did not utter stress calls': 14.7 ± 1.7 s, $p < 0.05$).

There were no significant correlations between the number of training sessions needed and any of the other variables in the proactive-reactive test ($R_s < 0.15$, $p > 0.15$).

4.2 Comparison of responses obtained in the proactive-reactive test, novel arena and novel object tests

The amount of time an individual spent being vigilant was positively correlated across the proactive-reactive test and the novel arena test ($R_s = 0.38$, $p < 0.05$, Figure 8). Further, the amount of time an individual spent being vigilant in the proactive-reactive test showed a negative correlation with the amount of time an individual spent standing ($R_s = -0.34$, $p < 0.05$), the amount of time an individual spent walking ($R_s = -0.26$, $p < 0.05$) and latency to vocalise ($R_s = -0.35$, $p < 0.05$) in the novel arena test. The amount of time an individual spent being vigilant in the proactive-reactive test was also negatively correlated with the amount of time an individual spent standing ($R_s = -0.27$, $p < 0.05$) and the amount of time an individual spent walking ($R_s = -0.28$, $p < 0.05$) in the novel object test.

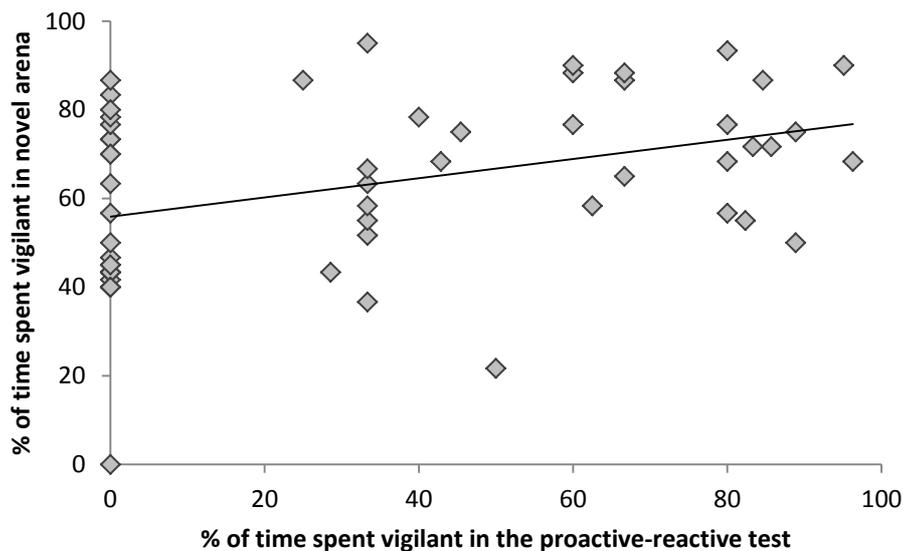


Figure 8. Individual red junglefowl chicks that were more vigilant in the proactive-reactive test were also more vigilant in the novel arena test.

Time to completion of the proactive-reactive test was positively correlated with the amount of time an individual spent being vigilant ($R_s = 0.26$, $p < 0.05$) and negatively correlated with the amount of time an individual spent standing ($R_s = -0.34$, $p < 0.05$) in the novel arena test. The amount of time an individual spent being vigilant in the proactive-reactive test did not show significant correlations with the amount of time an individual spent frozen ($R_s = -0.02$, $p < 0.05$) or latency to move ($R_s = -0.15$, $p < 0.05$) in the novel arena test. Neither did uttering of stress calls

in the proactive-reactive test show any significant relationships with the amount of time an individual spent frozen ($Z = 0.20$, $p = 0.84$) or latency to move ($Z = 1.17$, $p = 0.24$) in the novel arena test. Uttering of stress calls in the proactive-reactive test did show significant relationships with the amount of time an individual spent standing, walking and being vigilant in the novel arena test (Figure 9). Similarly, uttering of stress calls in the proactive-reactive test also showed significant relationships with the amount of time an individual spent standing (mean \pm SE, ‘uttered stress calls’: $11.5 \pm 2.6\%$, ‘did not utter stress calls’: $23.8 \pm 3.3\%$, $p < 0.05$), the amount of time an individual spent walking (mean \pm SE ‘uttered stress calls’: $3.2 \pm 0.8\%$, ‘did not utter stress calls’: $8.3 \pm 1.9\%$, $p < 0.05$), and the amount of time an individual spent being vigilant (mean \pm SE, ‘uttered stress calls’: $70.8 \pm 3.7\%$, ‘did not utter stress calls’: $53.8 \pm 5.1\%$, $p < 0.05$) in the novel object test.

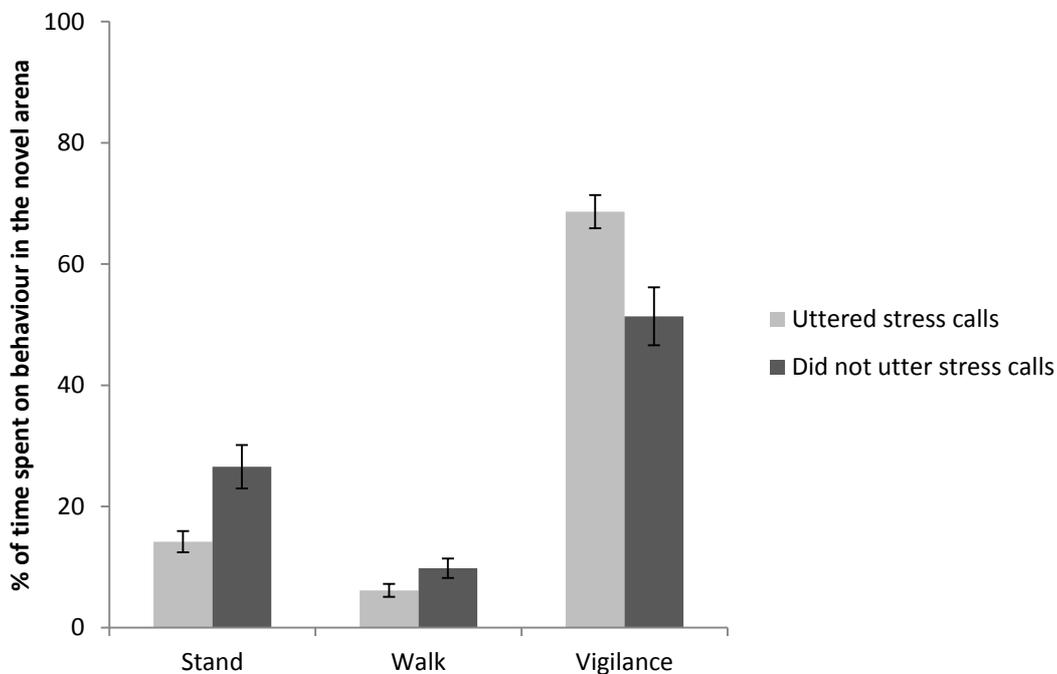


Figure 9. Individual red junglefowl chicks that uttered stress calls in the proactive-reactive test exhibited less standing (mean \pm SE, ‘uttered stress calls’: $14.2 \pm 1.7\%$, ‘did not utter stress calls’: $26.6 \pm 3.6\%$, $Z = 2.70$, $p < 0.05$) and walking (mean \pm SE, ‘uttered stress calls’: $6.2 \pm 1.1\%$, ‘did not utter stress calls’: $9.8 \pm 1.6\%$, $Z = 2.13$, $p < 0.05$) but were more vigilant (mean \pm SE, ‘uttered stress calls’: $68.6 \pm 2.7\%$, ‘did not utter stress calls’: $51.4 \pm 4.8\%$, $Z = -2.87$, $p < 0.05$) in the novel arena test, compared to individuals that did not utter stress calls.

How active an individual was in the proactive-reactive test was positively correlated with the number of escape attempts the individual performed in the novel arena test ($R_s = 0.34$, $p < 0.05$).

4.3 Comparison of responses obtained in the proactive-reactive test and association and reversal learning test

The amount of time an individual spent vigilant in the proactive-reactive test was positively correlated with the time it took for an individual to find the reversal colour the first time, after the rewarded colour had been switched ($R_s = 0.33$, $p < 0.05$). Uttering of stress calls in the proactive-reactive test also showed a significant relationship with the time it took for an individual to find the reversal colour the first time, after the rewarded colour had been switched (Figure 10). There were no other significant correlations between the proactive-reactive test and the association and reversal learning test ($R_s < 0.27$, $p > 0.40$).

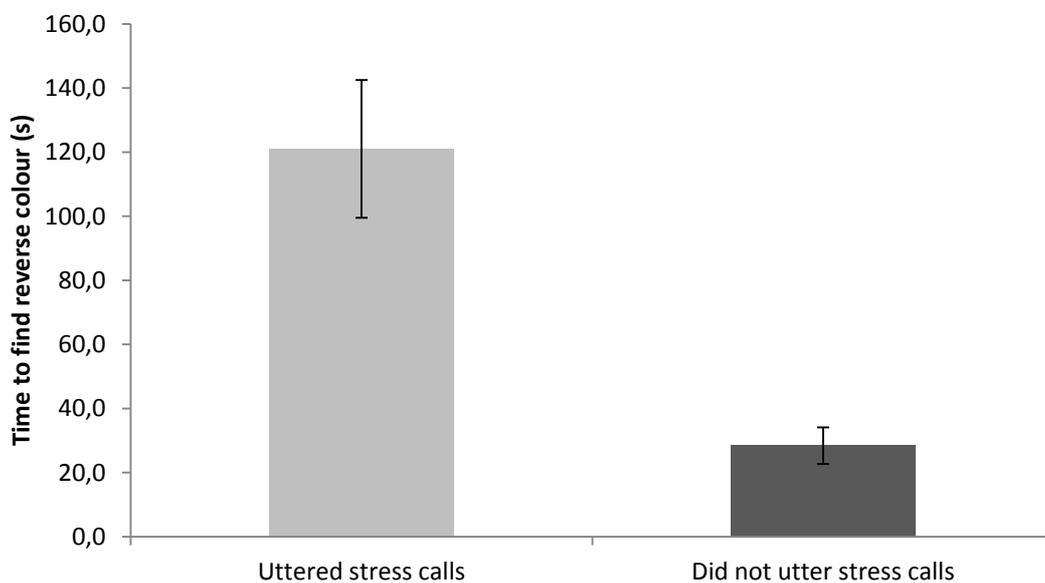


Figure 10. Red junglefowl chicks that uttered stress calls in the proactive-reactive test took longer time to find the reverse colour in the association and reversal learning tests (mean \pm SE, 'uttered stress calls': $121.0 \pm 21.5s$, 'did not utter stress calls': $28.4 \pm 5.7s$, $Z = -2.91$, $p < 0.05$).

5 Discussion

I have here shown that red junglefowl chicks differ, sometimes consistently, in their behavioural responses when exposed to various personality assays. In addition, these differences may be categorised as being proactive or reactive.

There was a clear relationship between elevated vigilance, long time to completion and whether an individual uttered stress calls in the proactive-reactive test. The amount of time an individual spent walking in the proactive-reactive test was strongly negatively correlated with the amount of time an individual spent being vigilant, as can be expected since these

two behaviours were the main behaviours observed in the test arena. As a consequence, individuals that were walking a lot had a short time to completion of the test and did not utter stress calls, while individuals that exhibited more vigilance were more stressed and did not complete the test that quickly. These two types show certain similarities to proactive-reactive individuals described in rodents, and red junglefowl chicks can therefore be categorised as reactive and proactive, respectively. Proactive individuals are expected to be more stressed when their routine is broken due to their lower behavioural flexibility (Koolhaas et al. 1999, Coppens et al. 2010). In my study, this stress manifests itself in the proactive-reactive test as increased vigilance and the uttering of stress calls.

Proactive individuals pay less attention to their environment than reactive individuals (Koolhaas et al. 1999, Coppens et al. 2010) which make proactive individuals less likely to discover the shortcut in the proactive-reactive test and these individuals therefore take longer to complete the test, which again fits with my observations and categorisation of the red junglefowl chicks as proactive or reactive. Reactive rodents on the other hand are more sensitive to changes in the environment (Koolhaas et al. 1999, Coppens et al. 2010) which make them more prone to discover the shortcut and complete the test faster than proactive individuals. Again, this fits the categorisation of the red junglefowl chicks, as made here.

Individuals who were more vigilant in the proactive-reactive test, were also more vigilant in the novel arena test, showing consistency in behaviour across contexts. Additionally, these individuals spent little time standing and walking in both the novel arena and the novel object tests. Individuals that uttered stress calls in the proactive-reactive test spent more time being vigilant and less time standing and walking in both the novel arena and the novel object tests. These results show that individuals who are more stressed in the proactive-reactive test are also more stressed in the novel arena and novel object tests. Meanwhile, individuals who spent more time walking and were not stressed in the proactive-reactive test also spent more time walking and standing in the novel arena and novel object tests. Individuals who spent less time being vigilant in the proactive-reactive test took longer to utter their first vocalisation in the novel arena. These results combined can be interpreted as that reactive individuals respond with more initial fear and caution to the novel arena and therefore take longer to vocalise. The reactive individuals show a more passive response to the novel environment (by standing and walking more). The proactive individuals on the other hand, show a more active response, trying to find a way to escape (by being more vigilant).

Individuals that spent more time being vigilant and uttered stress calls in the proactive-reactive test took longer to find the reversal colour in the association and reversal learning test. Proactive individuals are expected to do worse at reversal learning tests due to their lower behavioural flexibility (Koolhaas et al. 1999, Coppens et al. 2010) which supports the idea that increased vigilance and uttering of stress calls are indicative of proactivity in the red junglefowl. There was no correlation between the amount of time spent being vigilant in the proactive-reactive test and the number of associations needed to learn the assigned colours in the association and reversal learning test. This finding suggests that learning to associate a colour with a food reward is not related to a proactive or reactive personality type in red junglefowl chicks. This conclusion is somewhat supported by the findings of Titulaer and coworkers (2012) who showed that only the most difficult learning tasks are related to personality in great tits.

Individuals who showed high activity in the proactive-reactive test tried to escape more in the novel arena. High activity and trying to escape could be seen as proactive characteristics but since neither correlated with anything else it is hard to draw any conclusions on the generality of these observations. Activity and escape attempts should have correlated with the amount of time spent being vigilant, time to completion or stress calls if it was a sign of proactivity. More studies are therefore still needed to investigate further all the aspects of what proactive and reactive personality types in the red junglefowl express and are best described.

The number of training sessions needed to form a stable routine in the proactive-reactive test did not show any correlation with the amount of time spent being vigilant, time to completion or uttering of stress calls. If these behaviours are regarded as indicative of a proactive individual they would be expected to appear in conjunction with the need for fewer training sessions until the routine was formed, since proactive individuals are known to form routines easily (Koolhaas et al. 1999, Coppens et al. 2010, Quinn et al. 2011). This suggests that the categorisation of proactive and reactive individual red junglefowl chicks may differ in ease of routine formation in this species compared to previously studied species, or that the behaviours correlated within these two types of birds, differ. Further studies should therefore investigate the link between personality and learning in the red junglefowl to better understand this finding.

Taken together, individual red junglefowl chicks can be categorised as having proactive or reactive personality types but they seem to differ from other species in what describe these two personality types. The

reactive red junglefowl chicks' high behavioural flexibility and sensitivity to environmental changes are similar to those seen in reactive mice and rats (Koolhaas et al. 1999). However, proactive and reactive red junglefowl chicks do not show any difference in routine formation which goes against results from mice and rats where proactive individuals form routines easier than reactive individuals (Koolhaas et al. 1999).

By learning how a particular species copes with stressful situations we can better understand and design their environment to facilitate these coping mechanisms potentially reducing development of abnormal behaviours and health issues caused by chronic stress. Having established that red junglefowl chicks can indeed be categorised as proactive or reactive it would be interesting to investigate if and how these two personality types relate to other aspects of stress handling, such as aggression in general and feather pecking in particular. Establishing relationships between feather pecking and proactive-reactive personality types could potentially help us breed poultry with reduced tendencies for this adverse behaviour, thus somewhat alleviating this serious poultry welfare problem.

5.1 Conclusion

Red junglefowl chicks can to a large extent be described as proactive or reactive based on behavioural responses in personality assays. Proactive red junglefowl chicks are more vigilant and likely to utter stress calls in test situations, but also pay less attention to changes in their environment and take longer time to adapt when routines are broken. Reactive red junglefowl chicks, on the other hand, walk more and are less likely to utter stress calls in the same test situations. Reactive individuals are sensitive to changes in their environment and adapt faster when routines are broken. However, there is no difference in routine formation between proactive and reactive red junglefowl chicks, suggesting that there may be species differences in how proactive and reactive individuals act and interact with their environment.

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