Final Thesis

Behavioural effects of food deprivation on red junglefowl (Gallus gallus) and White Leghorn layers

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1. Abstract

The aim of this study was to examine how food deprivation effects food-related and other behavioural systems of red junglefowl (*Gallus gallus*) and the domesticated White Leghorn layers. If an animal is denied to perform their natural behaviours, like eating, sleeping or preening, the motivation for the behaviour can increase. Behavioural systems may interact and motivation to perform behaviours may be influenced. After being deprived of a certain need the reaction can become exaggerated or abnormal. Food deprivation is often used in ethology research to motivate animals. The hypothesis in this study was that the chickens would become affected by the food deprivation and reallocate their behaviours. They would get more stressed and frustrated. Domestication effects and sex differences were explored. The birds were tested in four standardized behavioural tests; food consumption test, general behavioural test, open field test and novel object test. The results showed that they foraged and explored more, had less comfort behaviours, and less perching the longer they had been without food. They did not show a higher degree of frustration, stress or aggressive behaviours. There were domestication effects, where the Leghorns seem to have lost some of their ability to respond adaptively to food shortage. Differences between the sexes were found, where the females foraged more and the males were more stressed. The conclusion was that the birds do not get more stressed when food deprived, but they forage and explore more which is a desirable effect of food deprivation used in ethological research.

Keywords: fowl, chicken, hunger, food deprivation, behaviour, motivation, open field, novel object

2. Introduction

Food deprivation is a method that is frequently used in ethology research and is a way of motivating animals to perform various tasks. The behaviours which animals have a relatively large need to perform, and where the motivation for it can get increased by thwarting, is eating, drinking, sleeping, mating, moving, playing, exploring and stimulation of senses, and also cleaning behaviours like preening and dust bathing (Friend 1991). If an animal is denied to perform their natural behaviours, the motivation for it can get even stronger and after being deprived of a certain need the reaction can get exaggerated or abnormal. An example of this is the calf suckling of other things than their mothers teat when separated from her (Friend 1991). There are a number of behavioural systems controlling the actions of an animal and these systems can include feeding, mating, exploring and sleeping. The behaviours are coordinated by behavioural mechanisms and their activation results in a specific perception, motor pattern or internal state. It is the behavioural mechanisms that form the larger units of behavioural systems. These mechanisms and systems represent a high level of complexity between behaviours.
such as feeding, sleeping and aggression (Bohlius & Giraldeau 2005). Different
behavioural systems may interact or suppress each other and the motivation to
perform different behaviours may be influenced. One example is the fearfulness
versus exploring behaviours, two behavioural systems which is thought to interact
when an animal is presented to a novel or unfamiliar situation. These behavioural
systems are both activated almost conclusive by external stimuli, and low levels
can cause approach, at moderate levels withdrawal and immobility at high levels
(Bohlius & Giraldeau 2005). An increased motivation in animals to perform
behaviours during prolonged times of deprivation, gives rise to chronic stress that
in turn can lead to suppressed immune system, changed metabolism and
stereotypic behaviours (Friend 1991).

Though many studies have been conducted concerning caloric restriction in
animals, very little information have been yielded so far about complex behaviours
and cognitive functions when deprived of food (Vitousek et al 2004). One of the
studies concerning food deprivation has been performed on broilers to test their
feeding motivation when deprived of food, by Bokkers et al (2004 a). The maximal
price that the chickens were willing to pay to get a food reward was measured.
In this case how many food pecks they would perform to get the food, compared with
their weight and food deprivation. The deprivation levels was 50 % or 75 % of the
chickens normal food amount when fed ad libitum. The broilers that were deprived
for 50 % of their normal food access were willing to pay a higher maximal effort to
get the food reward and they reacted faster to presented food, than the chickens
deprieved for 75 %. Only long term effects of food deprivation could be detected.
The results indicated that the chickens are sensitive to different levels of food
shortage, and also that they have the ability to balance their investments. (Bokkers
et al 2004 a). Another study shows that chickens vocalize more when deprived of
food (Bokkers et al b ). The ability and motivation to walk for food were tested on
fast- and slow growing broilers. They were deprived of food for 3 and 24 hours.
The fast growing broilers vocalized more and walked slower than the slow
growing broilers. Chickens deprived of food for 24 hours vocalized more than the
chickens deprived of 3 hours (Bokkers et al 2004 b).
A study with layer hens shows that they gakel call more due to frustration when
food deprived. They have higher frequency of gakel calls when presented to a
familiar food signal, than they have when not deprived of food (Zimmerman et al
2000). Social behaviour and feeding motivation has been tested by Keeling et al
(1996). The chickens were deprived of food for 15, 30, 60 and 120 minutes. Food
pecking and the amount of food consumed increased linearly with the length of the
food deprivation periods (Keeling et al 1996). Aggression is another aspect that
has been tested, by Haskell et al (2000). Pairs of dominant and subdominant birds
were tested with either water or food deprivation. They were allowed to walk
together through a corridor to a test arena with a food or water reward. Every
fourth test they could not reach the food or water. When they where refused to get
their reward and at the same time was food deprived, the frequency of aggressive

behaviour increased. They also became more active (Haskell et al 2000).

In a study with pigs the the aim was to determine whether their exploring behaviours was motivated by foraging or exploring the environment (Day et al 1995). The pigs were both deprived of food and introduced to new environments. When the pigs were deprived of food they were rooting more in the substrate and they were more active. The results showed that the pigs exploration motivation increases when they are deprived of food, probably due to raised hunger levels (Day et al 1995). Another study involving food deprivation was conducted on cows by Schutz et al (2006). Cows, both lactating and none lactating, were deprived for 0,3,6 or 9 hours. The cows were then tested how far they were willing to walk for food. The total length that the lactating cows were willing to walk increased linearly with the length of the food deprivation periods. The cows with a lower body weight were also willing to walk further to get the food than did the heavier cows. According to the authors this is a good method to test feeding motivation (Schutz et al 2006).

Two different breeds of fowl were used as model animals in this study to examine behavioural effects of food deprivation. A wild type of fowl and a domesticated strain were used for an opportunity to compare domestication effects. Red jungle fowl represents the wild type of fowl and is the ancestor of all domesticated breeds. The White Leghorn layers represents the domestic breed. The systematic breeding to increase the production off eggs and meat from fowl started a little more than a hundred years ago and has has given rise to two different kind of domesticated fowl, egg layers and fast growing broilers. The last 30 years commercial hybrids strains have appeared. The White Leghorns are selected and bred to increase their egg laying and growing rate, representing a high level of domestication (Jensen & Andersson 2005). They are so called light hybrids; the body size and food intake have decreased while egg size and number have increased, compared to other selectively bred layers (Appleby 2004). The selective breeding has also influenced the behaviour of the domestic fowl, this is why it is of great interest to compare any differences of behavioural effects between domesticated and the jungle fowl type, following food deprivation. Research shows that the White Leghorn layers tend to be less fearful in novel situations an to humans, they have less social interactions and forms dominance relations slower (Jensen & Andersson 2005) and they have a more energy conserving behavioural strategy (Odén 2005). The wild type of fowl, as represented by red junglefowl, has a more extended and wide ranging feeding and exploring behaviour (Jensen & Andersson 2005). The jungle fowl became domesticated about 8000 years ago, probably used by humans in religious context for a start. The red jungle fowl (Gallus gallus), origins from Asia where it is confined to forests and thick vegetation. The fowl consumes seeds, fruits, herbage, invertebrates and sometimes carrion. They live in flocks, which usually consists of a male and one or more females (Appleby 2004). The males lead the flock and protect it against predators.
There are separate pecking orders between males and females and males are usually dominant over females. While the flock eats, dust bathes or is foraging the males spend much of their time watching out for dangers, intruders and protecting the territory. Research is indicating that the presence of a rooster has calming effect on the hens. (Odén 2003)

Food deprivation in ethological studies is often used in different context but no wider inquiry has been conducted about how the different behavioural motivation systems may interact in a situation of food shortage. The aim of this study is to find out what effects food deprivation have on the behaviour of chickens, and thereby also how it might effect the outcome of different research based on it. Fear, stress, hunger level, frustration and aggression are investigated as well as quantifying and measuring the foraging and exploring behaviours performed when deprived of food for various periods of time. Gender and domestication effects are explored. The hypotheses is that food deprivation makes the birds more stressed, increases aggression and frustration. They might become more fearful in novel situations, something that could inhibit exploration and foraging behaviours. The red jungle fowl should be more fearful than the White Leghorns, and this is expected to increase when they are food deprived. The Leghorns might show a different behavioural respond to the treatment than the red junglefowl due to domestication effects. There should also be some differences of behavioural reactions depending on which sex the birds have.

3. Materials and methods

The tests designed and used in this project consisted of a general behavioural test, an open field test, a novel object test and a feeding consumption test. The general behavioural test was designed to explore the behaviour of the chickens of all spectra. The open field test was used to monitor fear and motivation to explore and move in a novel environment, and also general behaviours, all following deprivation periods. The novel object was used to monitor fear and motivation to explore a novel object as well as general behaviours. The food consumption test was used to measure the amount of food eaten by the birds following different food deprivation periods, and thereby determine their actual hunger levels. The deprivation periods that was applied to the birds were 0, 3 and 24 hours. This represented a period of no deprivation as well as a short term and long term deprivation of food. This was also the time length that was most suitable to implement practically in the study. All the tests were conducted in a balanced way according to time of day, localization in deprivation pens, localization in test boxes, individuals in groups, and test order per individual and deprivation period. The tests were conducted during spring 2007.

3.1. Animals

Red junglefowl (*Gallus gallus*) and White Leghorn layers (*Gallus gallus*)
domesticus) were used in the tests. The red junglefowl (RJF) strain descends from a zoogroup that has been kept at Linköping University since 1997 and the White Leghorn layers (WL) are SLU 13 strain that has been selected for high profit since about 1970 (Jensen & Andersson 2005). There were an age difference of five weeks between the breeds. There was an adjustment in the time lapsed between the testing of the two breeds so that they all would be at the same age by the times that the tests were conducted. They where all 18 weeks when the tests started.

3.2. Food consumption test

The food consumption test were designed to measure the amount of food eaten by the birds after the different periods of food deprivation and the porpoise was to determine their hunger level. The birds were placed individually in the the deprivation pens with one food trough for each bird. The test was repeated at three occasions and therefore allowing the individual birds to be tested for all the three food deprivation periods. Each test consisted of two test periods; a short period of feeding during five minutes, and a longer period of two hours.

3.2.1. Materials

18 individual chickens were used from each breed, nine of each breed were females and nine were males. 18 production pens, 54 cm high, 61 cm wide and 54 cm deep, were used. The pens were furnished with a nest site, which had a dust bath on top and a perch to the side. Water was accessed through water nipples in the far back at the cage roof. At the front, which also acted as a sliding door, food troughs was placed. 18 food troughs and commercial chicken food were used.

3.2.2. Test procedure

On day one the birds were captured from their home boxes. They were placed individually, with one chicken in each pen. Each pen were marked with a number, and the same number was noted on the food trough attached to the pen. Day two was used as a habituation day and the birds were fed continuously. Day three one third of the birds that were going to be deprived of food for 24 hours had their food troughs taken away. On day four the 3 hour deprivation time was started for another third of the birds, so that they would be ready at the same moment as the birds deprived for 24 hours. The remaining third was deprived for 0 hours, and had continuous access to food until the start of the test. When their deprivation periods were finished the lights was turned off and the food troughs were removed and taken to an adjacent room. 18 plastic cups had been prepared, and weighed on an electronic scale in advance, all containing 150 gram of chicken food. The troughs were emptied and each of them refilled with 150 grams of food. The troughs were replaced in the pens still in the dark. Then the light was turned on again starting the first test period and the birds was allowed to eat for five minutes. When five minutes had passed the lights was turned off again and the food troughs were yet
again removed from the pens. The troughs with food inside were weighted and the weight in gram was noted. Then the food troughs were put back in its pen respectively and the light was turned back on. The same moment the lights went on the next test period was started, allowing the birds to eat freely from the troughs for two hours. When the time had lapsed the lights was turned off and the food troughs were once again removed from the birds. The troughs were weight again and the weight was noted for all the 18 troughs.

3.3. General behavioural test

The general behavioural study included observations of the birds in cages that allowed them to perform all their natural behaviours, except for the access to food. They were placed in groups of three, with either two males and one female or two females and one male. The test was repeated at three occasions and therefore allowing the individual birds to be tested for all the three food deprivation periods.

3.3.1. Materials

In the general behavioural test 18 individuals of RJF and WL layers respectively were used. Nine of them were females and nine of them were males. Six cages for observational tests were used, size 100 cm wide, 200 cm long and and 180 cm high. They were built out of sections that consisted of frames with chicken wire and particle board covering the lower part of the sections up to 61 cm. The cages contained a water bowl, a perch placed just above the particle board, 3 cm in diameter. A layer of wood shavings was covering the floor. The pens were built side by side in the middle of the test room. The size of the room was 6,5 meters * 3 meters. The lux by the test cages was measured to 22 and the temperature was 20 degrees Celsius. Between the tests the chickens were kept in small production pens consisting of thin metal bars, 54 high, 61 cm wide and 54 cm deep. The pens were furnished with a nest site,which had a dust bath on top and a perch to the side. Water was accessed through water nipples in the far back at the cage roof. At the front, which also acted as a sliding door, food troughs were placed.

3.3.2. Test procedure

0 hour, 3 hours and 24 hours were the periods of food deprivation that the chickens were allotted before the test sessions. All chickens was tested for each deprivation period in a balanced way, with a total of three test days. Day one 18 individuals were captured in their home boxes in full dark and placed in transport boxes. The birds were moved to the room with the production pens where they were weighted and marked with leg marking rings. After this they were placed in a constellation of three individuals per production pen.

The next day they had an adjustment day, and on day three the animals that was allotted with 24 hour deprivation had their food taken away. On the fourth day the 3 hour animals had their food taken away in the morning, which was overlapping
with and ending at the same time as the 24 hour deprivation period. When the deprivation periods had passed, the light was switched off in both the test room and in the deprivation room, and the chickens were transported from their deprivation pens to the test cages in the test room. The individuals were both transported and replaced together in the same constellation as in the deprivation pens. When all the birds were moved to the test boxes the light was turned back on, and 30 minutes of adjustment time were applied so that the chickens would get used to their new environment. That included the human observer and the timers beeping. When the observation started, the first chicken in cage A was observed for one minute, recording behaviour every tenth second. Then a new individual in next cage were observed for one minute, before moving on to next chicken in next cage until all the six cages had been observed and all the individuals had been observed three times. The test took about an hour to complete. The test order of the individuals in the protocol were planned and created in advance. Between the test occasions there were always a day of recovering and ad libitum feeding so that they would not be hungry when the tests started again. The 3 hour individuals always had a few hours to eat in the morning before the food was withdrawn on the test day so that they would be fully fed. The tests always started at 12.00 A:M.

3.3.3. Variables

In the general test the variables analysed were % of intervals with foraging, exploring, move/alert, inactive, comfort behaviours, social behaviours, aggressive behaviours, stress behaviours, gakel call and perch.

3.4. Open field

The open field test consisted of placing the birds individually in a circular arena with different zones marked out on the arena floor. They were recorded with a video camera and their vocal expressions were sampled in place. The behaviours were caught on tape and observed at a later occasion. Each individual bird took part in the test only one time, so that the arena would present to them a new environment. They were allotted one of the three different deprivation times of 0, 3 or 24 hours. The test were divided into three occasions, on three different test days, testing a third of the birds each test day. After the test in the open field arena each bird was immediately placed in the novel object test, which was set up and carried out at the same time.

3.4.1. Materials

26 RJF and 27 WL were used in this test. Half of the individuals from the RJF were females, and half of them males. In the WL layers 14 individuals were females and 13 were males. A circular arena measuring 1.90 m in diameters and 61 cm high were built out of particle boards. The floor was divided into eight zones, four inner and four outer which were marked out with black tape. The arena was
covered which a mesh, and attached to the arena walls with clips. A film camera was attached above the arena in one corner so that the entire arena floor could be seen on the monitor. Two spotlights were placed on opposite sides of the arena and they were connected with a common switch. The lux in the arena was measured to 22. In the other corner, opposite to the film camera was the opening spot in the mesh for releasing the birds on to the start zone in the arena. In this corner the mesh was attached with removable clips so that the mesh could be opened. The film camera was connected to a VCR and a monitor.

3.4.2. Test procedure

On day one the birds were captured from their home boxes and placed in the deprivation pens, three individuals per cage. Two of the individuals in each group were always females or males. The testing was divided into three days per breed where nine birds were tested each time. Day two, the day after capturing, was used as habituating day. On day three the first deprivation period of 24 hours was started for a third of the birds. At day four in the morning, the birds that was going to be deprived of food for 3 hours had their food troughs removed. The tests always started at 12.00 A.M. The birds were tested one at a time. The light was turned off both in the test room and in the room with the birds in deprivation pens before each test. The individual bird was collected from the deprivation pen, their tag number was noted and it was then placed in a transport box, and carried to the test room. The bird was picked up from the transport box and placed in the start zone in the arena, still in the dark. The VCR was set on record and then the light was turned on via the common switch. The bird was then recorded for ten minutes. The vocalization during the session was recorded. When the ten minutes had lapsed a whiteboard with the birds ID and deprivation number noted on it, was picked up and held in front of the camera a few moments so it would be visible for later. The recorder was then switched off. The light was turned off and the animal was removed from the arena and carried away to participate in another test, the novel object test that was running directly after the open field test.

3.4.3. Variables

In the open field test the variables analysed were % of intervals with foraging, exploring, move/alert, inactive, comfort behaviours, escape, stress behaviours, and gakel call. Also the number of zones crossed and crowings were analysed.

3.5. Novel object

The novel object test consisted of a rectangular test cage with a start box in one end and a food trough with a novel object in the other end. In this case a red and white fish float was used as a novel object, with the purpose to act intimidating on the birds. The birds were placed in the test cage individually. In the novel object test general behaviours were observed but also number of zones crossed and time
3.5.1. Materials

26 RJF and 27 WL was used in the test. A test cage with the sizes 200 cm long, 180 cm high and 100 cm wide was used. It was assembled by frames with chicken wire and particle board covering the lower part of the frames, 61 cm high. One frame was also used as a roof, covering the entire arena top, preventing the birds to escape. The floor was divided into four equal zones, each 50 cm, marked out with black tape. Two spotlights were attached in the roof in each end of the novel object test cage and they were connected together. A piece of cardboard, 44 cm * 60 cm was used to cover the opening of the start box into the runway. The measure of the start box was 40 cm deep, 42 cm wide and 40 cm high. The opening end of the test cage had its lower part covered with a particle board, that had an opening cut out wide enough to fit the start box opening. Two food troughs were placed in the other end of the runway, one upside down and the other one on top of it, with a layer of chicken food at the bottom, about 1 cm thick. A fish float was placed in the middle of the trough, on top of the food. The lux was measured to 22 on the test cage floor and the room temperature to 20 degrees Celsius.

3.5.2. Test procedure

The novel object test was running directly after the open field test. The lights were turned off in the test room and the bird was removed from the open field arena. Then it was immediately placed in the start box of the novel object test cage, head facing the opening. The cardboard in front of the opening was removed while still in the dark allowing the bird to enter the novel object runway from the start box. Then the timer and the lights was turned on at the same time, starting the observation. The bird was observed during five minutes. Behaviours of the bird was sampled and location in zone A-D in the test cage were noted every tenth second.

3.5.3. Variables

In the open field test the variables analysed were % of intervals with food peck, explore food, float peck, latency to start eat (seconds), foraging, exploring, move/alert, inactive, comfort behaviours, stress behaviours, and gakel call. And the total number of zones crossed on the arena floor.

3.6. Sampling methods and ethograms

In the general behaviour test the social and stress behaviours were recorded with 1/0 sampling between every tenth second, during one minute per individual repeated three times per chicken. The other behaviours were sampled instantaneously every tenth second during this minute. When a chicken in each of
the six cages had been observed, the experimenter had one minute to move back to the first cage, starting to observe a new individual in the cage, when the minute had passed. The test took an hour to complete.

In the open field test stress behaviours and escaping were recorded with a 1/0 observation between each tenth second beep of the timer during ten minutes. The other behaviours recorded during the test session were recorded with instantaneous sampling every tenth second during ten minutes per individual. Also zone crossings where sampled with instantaneous sampling every tenth second. The behaviours were decoded from the videotapes a few weeks after the test occasion. Crowing and gakel calling was recorded during actual testing.

Behaviours that was recorded during the novel object test were sampled every tenth second during five minutes with instantaneous sampling. In the test the behaviours around the food trough was also recorded with instantaneous sampling every tenth second, which consisted of explore food, food peck and float peck. Stress behaviours were recorded with a 1/0 sampling between every tenth second. Zone crossing where sampled with instantaneous sampling every tenth second.

<table>
<thead>
<tr>
<th>Behaviours</th>
<th>Description</th>
<th>Behavioural category</th>
<th>Recorded in test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground/perch</td>
<td>The bird is located on ground or perching</td>
<td>Ground/Perch</td>
<td>GB</td>
</tr>
<tr>
<td>Ground peck</td>
<td>Pecks at food or ground</td>
<td>Foraging</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Ground scratch</td>
<td>Scratches with feet and takes one or two steps</td>
<td>Foraging</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td></td>
<td>back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explore ground</td>
<td>Walks or stands with head close to the ground</td>
<td>Explore</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Explore object</td>
<td>Pecks at object other than feed on ground</td>
<td>Explore</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Drink</td>
<td>Drinking at the water container</td>
<td>Forage</td>
<td>GB</td>
</tr>
<tr>
<td>Walk</td>
<td>Movements of legs in normal speed</td>
<td>Active</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Sit/stand alert</td>
<td>Sits or stands alert, eyes open</td>
<td>Active</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Behaviour</td>
<td>Description</td>
<td>Category</td>
<td>Country(s)</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Sit/stand relaxed</td>
<td>Stands or sits with eyes partly or fully closed, no head movements.</td>
<td>Inactive</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Run</td>
<td>Leg movements faster than walking</td>
<td>Active</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Preen</td>
<td>Trimming of plumage with beak</td>
<td>Comfort behaviours</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Dust bathing</td>
<td>Dust bathing movements according to Vestergaard et al. 1990</td>
<td>Comfort behaviours</td>
<td>GB, OF, NO</td>
</tr>
<tr>
<td>Peck</td>
<td>Peck peck gently with beak at other bird, non-aggressive</td>
<td>Social</td>
<td>GB</td>
</tr>
<tr>
<td>Aggressive peck</td>
<td>Aggressive peck and receive aggressive peck: pecks or receives peck, the giver´s beak being above the receiver´s head</td>
<td>Aggressive behavioural</td>
<td>GB</td>
</tr>
<tr>
<td>Fight</td>
<td>Being involved in aggressive fights, more than just one peck</td>
<td>Aggressive behaviour</td>
<td>GB</td>
</tr>
<tr>
<td>Chase</td>
<td>Follow or is followed by another bird in an aggressive context</td>
<td>Aggressive behaviour</td>
<td>GB</td>
</tr>
<tr>
<td>Sexual behaviour</td>
<td>Mating, courting, crouching</td>
<td>Social</td>
<td>GB</td>
</tr>
<tr>
<td>Gakel call</td>
<td>Sound composed of elongated note, with rising frequency</td>
<td>Gakel call</td>
<td>GB</td>
</tr>
<tr>
<td>Head flick</td>
<td>One fast flick of the head</td>
<td>Stress behaviours</td>
<td>GB</td>
</tr>
<tr>
<td>Yawn</td>
<td>Opens mouth, yawns</td>
<td>Stress behaviours</td>
<td>GB</td>
</tr>
<tr>
<td>Number of zones</td>
<td>Number of zones crossed on the ground</td>
<td>Number of zones</td>
<td>GB</td>
</tr>
<tr>
<td>Food peck</td>
<td>Pecks at food in through</td>
<td>Food peck</td>
<td>NO</td>
</tr>
<tr>
<td>Explore food</td>
<td>Looks at food in through</td>
<td>Explore food</td>
<td>NO</td>
</tr>
<tr>
<td>Behaviour</td>
<td>Description</td>
<td>Behaviour</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------------------------------------------------</td>
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<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Float peck</td>
<td>Float peck</td>
<td>Float peck</td>
<td>NO</td>
</tr>
<tr>
<td>Start eat</td>
<td>The time when the bird starts to eat from through</td>
<td>Start eat</td>
<td>NO</td>
</tr>
<tr>
<td>Crowing</td>
<td>Loud vocalization with three or four notes</td>
<td>Crowing</td>
<td>OF</td>
</tr>
<tr>
<td>Escape</td>
<td>Escapes from arena, forcing itself through the mesh</td>
<td>Escape</td>
<td>OF</td>
</tr>
<tr>
<td>Fly/jump</td>
<td>Jumps and flaps its wings, transporting itself a distance</td>
<td>Move/alert</td>
<td>OF</td>
</tr>
</tbody>
</table>

### 3.7. Statistical analysis

The computer program SPSS (version 14.0) were used to calculate statistics and results. In the general behavioural test the total of all behavioural observations recorded for each individual in a test session were calculated in percent. Then the different behaviours were grouped in categories, and the mean per cent of the behaviours included in each group were added together. The behavioural category created were foraging, exploring, active, inactive, comfort behaviours, and social and stress behaviours. Then a calculation of significance of the differences between deprivation time, breed and gender according to each behaviour was performed. This was done by using the General linear model, Repeated measurements, including the behaviour categories in all deprivation periods.

For the open field and the novel object the recorded data was processed in the same way with calculating the mean per cent of all behaviour and behaviour categories. Then the variables were tested in General linear model, univariate measurement. For both tests the model included the effects of deprivation time, breed, sex and also interactions between deprivation time and sex, and deprivation time and breed. The mean number of zones crossed by the birds were also calculated in both open field and novel object and the significance were then received with the univariate measure. From the novel object test the mean time in seconds for the birds to start eat were also calculated. Only the birds that actually started to eat during the test were included in the calculation. A Chi-2 test were also performed, comparing the proportion of individuals that actually started to eat regarding sex, breed and deprivation time.

The food consumption test consisted of a five minute feeding interval and the total amount eaten (in grams) during 2 hours. The total food intake and the feeding speed for each individual for each deprivation period was calculated. The food amount consumed during five minutes was divided with five and from this a total gram per minute consumption was received, representing the birds feeding speed.
The total food consumption was represented by the total amount of food consumed by the individual bird during 2 hours. The differences in food intake was tested with an ANOVA model including effects of deprivation time, breed and sex. The significance was set to p<0.05 for all the tests. All the graphs of the results are presented with a standard error of the mean.

4. Results

4.1. Food consumption test

The amount of food consumed during the 2 hour feeding session increased with the length of the deprivation period (F_{2.64} = 52.9; P<0.001)(Fig.1). There where also a significant difference between the sex (F_{1.32} = 7.2; P<0.05). The females always consumed more food than the males in both breeds. The feeding speed of all birds increased with the length of the deprivation time (F_{2.64} = 46.6; P<0.001) (Fig. 2).

There were also a significant difference between the sex ( F_{1.32} = 3.2; P<0.05). Males of both breeds had a higher feeding speed than the females when deprived for 0 hours, but when the birds where deprived for 3 or 24 hours the females had a higher feeding speed than the males.

4.2. General behavioural study

The RJF had about the same level of foraging behaviours when deprived for 0 or 3 hours (Fig. 3) and it increased significantly when the birds were deprived for 24 hours (F_{2.64}=4.2; P<0.05). At 24 hour deprivation the RJF were foraging almost
twice as much as the WL ($F_{1.32}=4.9; P<0.05$). The birds of both breeds had similar degree of exploring behaviours when they were deprived for 0 or 3 hours, but it increased significantly when deprived for 24 hours ($F_{2.64}=11.5; P<0.001$) (Fig.4).

There were significant differences in the occurrence of move/alert behaviors regarding sex and breed, but not deprivation time (Fig. 5). The WL layers had more move/alert behaviors than the RJF at all deprivation levels ($F_{1.32}=14.2; P<0.001$) and the males of both breeds always had more move/alert than the females at all deprivation times ($F_{1.32}=8.8; P<0.01$). There were no significant differences regarding deprivation time. There were no significant differences on the level of inactive behaviors between the sex, breed or deprivation time and the occurrence was low. When food deprived for 24 hours the occurrence of comfort behaviors decreased almost by half for all the birds ($F_{1.32}=3.7; P<0.001$) (Fig 6). There were also significant differences between sex ($F_{1.32}=9.2; P<0.05$) and breed ($F_{1.32}=7.4; P<0.01$). The RJF had more comfort behaviors than the WL at all deprivation times. When deprived for 0 hours the females of both breeds show more comfort behaviors than the males. There were significant differences of the level of perching regarding to deprivation time ($F_{2.64}=6.7; P<0.05$) but also concerning sex ($F_{1.32}=6.1; P<0.05$) and breed ($F_{1.32}=21.9; P<0.001$) (Fig 7). The RJF had the same level of perching at 0 and 3 hours but had a significantly lower perching level at 24 hours. The WL had about the same level of perching when deprived for 0 or 3 hours. When deprived for 24 hours the perching of the WL females increased significantly, but the males at the same time decreased their perching significantly. The RJF was perching more than the WL at all deprivation times and the females were always perching more than the males.
The level of social behaviors showed a significant difference regarding to sex ($F_{1.32}=19.4; P<0.01$). Females of both breed showed a higher level of social interactions than did the males at all deprivation times. At 0 hour deprivation only the WL males showed aggressive behaviors. At 3 hour deprivation only the WL females showed aggressive behaviors. At 24 hour deprivation the RJF females showed a high level of aggression and both WL females and males showed a small level of aggression. The frequency of the gakel calls of the birds only differed
between sex ($F_{1.32}=3.3; P<0.05$) (Fig 8). Females had more gakel calls all together, but the frequency was low and irregular amongst the birds. No significant differences of the level of stress behaviors where detected between sex, breed or deprivation times.

4.3. Open field test

The WL always crossed significantly more zones in the open field arena than did the red jungle fowl regardless of deprivation time ($F_{1.47}=8.8; P<0.01$) (Fig 9). No food deprivation effects was detected. The longer the birds had been deprived of food the more they foraged in the open field arena ($F_{2.47}=3.3; P<0.05$) (Fig 10). The females always foraged significantly more than the males regardless of deprivation time ($F_{1.47}=23.4; P<0.001$). The females of both breeds always had more exploring behaviors than the males regardless of deprivation time ($F_{1.47}=11.2; P<0.01$). The males of both breeds always had more active behaviors than the females regardless of deprivation time ($F_{1.47}=26.3; P<0.001$). None of the birds showed any inactive behaviors in the open field. The birds had the highest occurrence of comfort behaviors when deprived for 0 hours ($F_{2.47}=3.9; P<0.05$). When deprived for 3 hours it decreased significantly and was only raised slightly again at 24 hour deprivation. The RJF had significantly more comfort behaviors than did the WL at all deprivation levels ($F_{1.47}=7.7; P<0.01$). There where only one WL female that escaped from the open field arena. No significant differences existed. There were low levels of gakel callings at all deprivation levels for both breeds and for both females and males. No significant differences between sex, breed or deprivation time existed. The males of both breeds always showed significantly more stressful behaviors than females, except for the jungle fowl females at 3 hour deprivation ($F_{1.47}=7.8; P<0.01$)(Fig.11). The number of crowing that the males performed

![Figure 9. Number of zones crossed (average % of crossings) for each breed and sex at different deprivation times, obtained in the open field test.](image)

![Figure 10. Frequency of foraging behaviour (average % of observations) for each breed and sex at different deprivation times, obtained in the open field test.](image)
during the open field test differed between the breeds (Fig.12). The WL were always crowing more than the RJF regardless of deprivation time.

4.4. Novel object test

The birds crossed more zones when deprived for 0 hours than for 3 or 24 hours ($F_{1.47}=4.2; P<0.05$) (Fig.13). There were no significant differences of the time lapsed till the birds started to eat from the food through regarding the deprivation time. But there were significant differences between the breeds ($F_{1.23}=22.4; P<0.001$). The WL started to eat faster than the jungle fowl at all deprivation levels. At 0 and 3 hour deprivation only some of the RJF females started to eat, the males never ate at those deprivation levels. For the WL that started to eat about the same time elapsed regardless of deprivation level. The chi-2 test including the individuals that actually started to eat, showed significant differences of the breeds at 3 and 0 hours. (Tabel 2). A significantly larger proportion of the WL females started to eat, where only one of the RJF females started to eat, and all but one of the WL females started to eat. None of the RJF males started to eat but all of the WL males (Tabel 3).

The food pecks increased linearly with the length of the deprivation period for both breeds ($F_{2.47}=14.5; P<0.001$) (Fig 14). There were also significant differences between the breeds ($F_{1.47}=18.5; P<0.001$).

The WL performed a lot more food pecks than the RJF at all three deprivation levels.
There were significant differences between the breeds concerning how much they explored the food ($F_{1.47}=4.8; P<0.05$), but no significant difference regarding deprivation time. The WL explored the food much more than did the RJF when deprived for 0 or 3 hours but slightly less than the jungle fowl at 24 hour deprivation. A very low degree of float pecks were recorded and there where no significant differences neither between sex, breed or deprivation level. There were significant differences of the foraging behaviours between the birds regarding to deprivation time ($F_{2.47}=3.8; P<0.05$) (Fig 15).

The birds were foraging the most when deprived for 0 hours. When deprived for 3 hours they foraged considerably less, but it increased again at 24 hours deprivation. No significant differences existed neither between breed, sex or deprivation time regarding to the exploring behaviours. All of the birds decreased their move/alert behaviours the longer they had been deprived of food ($F_{2.47}=7.2; P<0.01$). There where also significant differences between breeds ($F_{1.47}=14.0; P<0.001$). The

### Table 2: The Chi-2 test comparing the proportions of individuals that started to eat in the novel object test.

<table>
<thead>
<tr>
<th>Breed/sex</th>
<th>Depr.time</th>
<th>Eat</th>
<th>No eat</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJF Females vs WL Female</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>RJF Males vs WL Males</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>WL Female</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>WL Male</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>JF Female</td>
<td>24</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>JF Male</td>
<td>24</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>WL Female</td>
<td>24</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>WL Male</td>
<td>24</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

**Total individuals**: 53

### Table 3: Significant differences from the chi-2-test regarding the proportion of individuals that started to eat in the novel object test.

<table>
<thead>
<tr>
<th>Breed/sex</th>
<th>Depr.time</th>
<th>Chi2</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJF Females vs WL Female</td>
<td>0</td>
<td>4.8</td>
<td>0.03</td>
</tr>
<tr>
<td>RJF Males vs WL Males</td>
<td>3</td>
<td>8</td>
<td>0.005</td>
</tr>
</tbody>
</table>

There were significant differences between the breeds concerning how much they explored the food ($F_{1.47}=4.8; P<0.05$), but no significant difference regarding deprivation time. The WL explored the food much more than did the RJF when deprived for 0 or 3 hours but slightly less than the jungle fowl at 24 hour deprivation. A very low degree of float pecks were recorded and there where no significant differences neither between sex, breed or deprivation level. There were significant differences of the foraging behaviours between the birds regarding to deprivation time ($F_{2.47}=3.8; P<0.05$) (Fig 15).

The birds were foraging the most when deprived for 0 hours. When deprived for 3 hours they foraged considerably less, but it increased again at 24 hours deprivation. No significant differences existed neither between breed, sex or deprivation time regarding to the exploring behaviours. All of the birds decreased their move/alert behaviours the longer they had been deprived of food ($F_{2.47}=7.2; P<0.01$). There where also significant differences between breeds ($F_{1.47}=14.0; P<0.001$).
RJF had more move/alert than the WL at all deprivation levels. None of the birds showed any inactive behaviours during the test. The only significant differences of the comfort behaviours was regarding to sex ($F_{1.47}=7.8; P<0.05$). The males of both breeds showed more comfort behaviours than the females at all deprivation levels, except for the RJF females at 0 hour deprivation which had more comfort behaviours than the males. The stress behaviours had significant differences regarding the sex of the birds ($F_{1.47}=4.5; P<0.05$) (Fig 16), where the males of both breeds showed more stress behaviours than did the females. Only the RJF females showed a low stress level at 0 and 24 hours deprivation, the WL layer females did not have any observed stress behaviours. There where no significant differences regarding the gakel calls sampled from the birds.

5. Discussion

This study showed that both RJF and WL consumed more food when deprived, which increased with the length of deprivation time and affected both feeding speed and total food intake. This is a clear measurement of how hungry they became after being deprived of food. The food deprivation did not seem to affect the levels of stress, frustration or aggression amongst the birds, besides the stress that they are exposed to during the actual handling and transporting to new enclosures and novel environments. The food deprivation increases motivation to forage and explore which is the desirable effect on food deprived animals for various behavioural tests. The comfort behaviours decreased with the length of the food deprivation, which can be explained by that they reallocated their behaviours and were instead exploring and foraging more. Domestication effects could be
seen, where the the WL did not respond as strategic as the RJF did to food shortage. The RJF increased their foraging and exploring, and decreased their perching. The WL responded with doing the opposite. The females foraged and explored more than the males, and had more social behaviours than the males. The males where more stressed than the females, as indicated by their higher frequency of stress behaviours.

5.1. Food consumption test

This test gave a strong support to that the chickens became affected by food deprivation regarding their hunger levels. They were hungrier the longer they had been deprived of food which they consumed more readily and faster. The raised hunger levels of the chickens correlated almost linearly to the level of food deprivation. They were clearly more motivated to eat after food deprivation. The fact that females consumed more food than males could be due to that the males were more stressed by the situation in the deprivation cages. During other tests in this experiment with open field and novel object the males showed higher stress levels. But it could also be due to the fact that the females were laying eggs and had a higher demand for energy resources. But at 0 hour deprivation, males consumed more food than the females, which could indicate that in conditions of stable food supply the males eat more than females. It was unexpected that the WL did not eat significantly more than the RJF, considering that they are larger and grow faster and thereby should have a higher nutritional need (Lindqvist 2003). It could be related to that the RJF lost more food from their troughs than they consumed, since they tended to scratch out more of their food due to their higher occurrence of foraging behaviours.

5.2. General behavioural test

Food deprivation induced a clear increase in foraging behaviours as well as exploring behaviours. The longer the chickens had been deprived of food the more they explored and foraged. This can be explained as a direct cause of increased hunger due to the food deprivation, which in turn increases motivation to explore more and forage more. The RFJ were always foraging and exploring significantly more than the WL, and this is a previously observed domestication effect. WL generally have a much lower level of foraging and exploring as well as other active behaviours (Schutz & Jensen 2001)(Jensen and Andersson 2005). This is due to resource allocation, where WL invest more in reproduction and growth and have generally more energy saving strategies (Odén 2005). This might also explain the reason for why the WL actually decreased their forage and exploring behaviours when deprived, they seem to lack the behavioural strategy to adjust to food shortage. The RJF instead increased their foraging and exploring behaviour. The WL though had more move/alert behaviour; they walked more, ran more, and sat more alert than the RJF. During the actual test occasion the observer noticed that
the WL seemed more agitated and were moving around more in the test cages. They often flew or jumped into the chicken wire of the enclosures, they ran around on the test cage floor and seemed more confused. They also vocalized more and pecked hard with their beaks on the fibre board, creating loud noise. They appeared to have more difficulty adjusting to their new environment. This was observed both during habituating time before the testing and during the testing. The RJF seemed to calm down faster in the test enclosures. These observed and sampled differences could be due to the fact that the WL have more difficulty to adjust to new environments (Väisänen & Jensen 2003). The WL might need a longer period of time than the 30 minutes that were applied in this test for adjusting to their new habitat. It might also be explained by that the WL were hungrier than the RJF, since they have higher nutrient and energy needs. The males of both breeds were also more active than the females. This could be due to differences in male and female behaviour allocation, were males tend to spend more time on watching out for predators and rivals when looking out for the flock. (Odèn 2003)

The occurrence of comfort behaviours significantly decreased the longer they had been deprived of food. The results showed that the birds spend less time on comfort behaviours, as they get more motivated to feed due to deprivation and allocate more time on foraging and exploring. The fact that the WL had significantly less comfort behaviours is opposing to previously known studies of the subject (Schutz & Jensen 2001) and there usually are no great differences between the breeds. The differences showed in this study might be explained by that the RJF were more feather pecked than the WL and they might have had a lower quality of their plumage.

It is a previously known domestication effect that RJF perches more than the WL, which was consistent with the results of this study (Schutz & Jensen 2001). The RJF perched significantly less when deprived for 24 hours, showing that they change their strategy when hungrier and they spend more time on the floor, foraging. The WL were instead perching more when deprived of food, this again shows on a lack of strategy to food shortage as a domestication effect.

The gakel call is a vocalization that the chickens make when frustrated, (Zimmerman et al 2000 a)(Zimmerman et al 2000 b) that was sampled and measured in the study. There were differences between the sexes regarding the occurrence of gakel calls, but there were a low level of registered gakel calls all together. At 0 hour deprivation only WL females were gakel calling indicating that they were frustrated. At 3 hour deprivation the RJF males and both WL males and females were frustrated. At 24 hour both WL males and females were frustrated and the RJF females. The fact that there were no significant differences regarding to deprivation time, shows that they do not get more frustrated by the food shortage. This is opposing to previously known studies on the subject (Zimmerman 1998)(Zimmerman et al 2000 a)(Zimmerman et al 2000 b). But these studies are
conducted in non reward situations with thwarting of an expected reward, which increases gakel calling of the birds. The subject might require further investigation to determine how frustrated they become by the situation of food deprivation.

There were no significant differences of the stress behaviours; both breeds and sexes showed a low level of stress regardless of deprivation time. This indicates that the chickens do not get very stressed by food shortage. The WL seemed more agitated than the RJF, as noticed by the observer, even though none of the samplings indicated this in the results.

The females of both breeds had more social interactions than the males. This could be because the males were more stressed or agitated and spent more time on move/alert behaviours, while the females in this test spent more of their time budget on social interactions. The observer could see that the females were involved in more frequent gentle feather pecks, but not the males.

There were no differences of the sampled aggressive behaviours amongst the birds, but the observer noticed a higher occurrence of males fighting in the WL than the RJF.

5.3. Open field test

The WL were considerably more mobile in the open field arena, with more crossed zones, indicating that they were less fearful of the situation than the red RJF. The fearfulness of the birds did not get affected by food deprivation. There were an increase of the foraging behaviours of the birds in the arena, the longer they had been deprived of food. This indicates an increased hunger level. The females were always foraging more than the males, which could be explained by the different behaviours that females and males have within the flock. The females explored more than the males. This can again be correlated to the flock behaviour where the males allocate more time watching for dangers and looking after the flock (Odén 2003). The males had more move/alert behaviours than the females, that can also be correlated to their rolls as sentinels. Both breeds significantly decreased their frequency of comfort behaviours when deprived for 3 or 24 hours. This is because they spend time on other behaviours such as foraging and exploring. The RJF had more comfort behaviours than the WL, which might be caused by a lower quality of the plumage amongst the RJF.

There were a low level of gakel callings at all deprivation times, indicating a relatively low degree of frustration amongst the birds, and which was not affected by the food deprivation. The males showed more stress behaviours than the females regardless of breed or deprivation time. It shows that the males became more stressed by the situation in the open field arena, where they were alone in a novel environment.

The fact that WL layers were crowing more than the RJF, could also be indicating more stress within the WL males. This can also relate to that they have more
difficulty to cope with new environments. Crowing is a vocalization that is used to mark territory and presence by the males and have been interpreted as an aggressive call (Collias 1987). Its sonogram though indicates that it may serve other functions as well because of its complexity. It attracts females and it also seems to be used for identification (Collias 1987). The crowing in the open field could be because the male wants to announce its presence to other rival males, but also signalling where he is to his missing flock members, since he is all alone in a novel situation. The more lost he is the more he crows.

The open field test shows that the birds get intimidated by the situation but they do not become more stressed or frustrated when deprived of food. They get hungrier and are foraging and exploring more the longer they have been without food.

5.4. Novel object test

The chickens did more zone crossing when deprived for 0 hours than deprived for 3 or 24 hours. This is due to the fact that when they were hungrier they walked to the food through and stayed there which resulted in less transportation around in the test cage. When deprived for 0 hours they were also moving around a lot more, they did often not stay by the food through but continued to switch zones.

Even though deprived of food no significant differences were noted for the latency to start eat, considering the individuals that did start eat from the food through. It was expected that the longer the birds had been deprived of food, the shorter the latency to start eat would be. The result could be because of the unevenly distributed samplings of the WL and RJF; the WL practically always ate regardless of deprivation time, and the RJF rarely started to eat. The only significant differences was concerning the breeds. The test showed that the WL had a lower latency to start eat than did the RJF. The RJF hesitated more, it took longer time for them to leave the start box and enter the arena, and also to approach the food through. Only one of the RJF started to eat when deprived for 0 hours, but many of the WL started to eat. Many of the WL only took a mouthful though and then left the food through again. This result was due to the fact that RJF is more fearful than the WL. It is a previously known domestication effect that the RJF are more fearful than the WL (Schutz & Jensen 2001). In the chi-2 test the proportions between the individuals that started to eat differed. One of the RJF females started to eat, indicating that they were not afraid to approach the novel object in the food through. Almost half of the WL females started to eat at 0 hour deprivation, indicating that they were not intimidated by the novel object. All of the WL males but none of the RJF males started to eat at 3 hour deprivation, indicating that the RJF males were afraid and did not approach the food through even though deprived of food. The WL was not afraid of the novel object in the test. The WL have lost many of they fearful reactions due to selective breeding (Jensen & Andersson 2005), which is clearly demonstrated by the novel object test.
There were a considerable increase in the amount of food pecks in the through depending on deprivation time, and the longer they had been deprived the more food pecks were recorded. This clearly shows that they were hungrier. The WL had a lot more food pecks, this should be correlated to the fact that they spend more time by the food through in the tests than did the RJF. They might also have been hungrier than the RJF because of their body size and higher nutritional need and therefore more motivated to find a food source.

Exploring of the food through were not affected by deprivation time, but the WL were exploring more. This can also be explained by that they spent more time by the through than did the RJF, since the RJF were more intimidated and did not dare to approach as fast or as much. At 24 hour deprivation the relationship was the other way around, and the RJF did more exploring. This could be explained by the the RJF increases their exploring when hungrier.

The low frequency of pecking towards the fish float in the through showed that they were avoiding it. This indicates that fish floats has a colour, size and shape that acts fearful on the chickens, when it acts as a novel object. It appears to be a good object to use in this kind of test.

In the novel object test a lower frequency of foraging were registered, in contrast to the other tests. This can be correlated to the construction of the novel object test cage, where once the food have been detected they stop foraging. Since they localized the food more frequently because they were hungrier when food deprived, they tended to spend more time on foraging when deprived for 0 hours. In the novel object test the red RJF had more move/alert behaviours, and this can also be explained by that the WL found the food through faster and spent most of their time there exploring and pecking there.

The novel object test clearly shows that the chickens get more motivated to explore and forage when they are deprived of food. This states food deprivation as a useful method in ethological research to increase motivation. Because of the nature and composition of the novel object test cage, the behaviours tended to switch proportions compared to the other tests, and it therefore need to be interpreted differently.

The males showed more comfort behaviour in the test cage than did the females. This can be explained by that the males were more stressed and started to preen as a displacement behaviour. This can be directly correlated to the fact that the males were more stressed than the females, since they had a higher occurrence of stress behaviours. There were no differences in the stress levels concerning deprivation time, so this test also shows that they did not get more stressed by being deprived of food.

They were not more frustrated by being food deprived, since there were a low and even level of gakel callings registered regardless of food deprivation time.
5.5. Summary of discussion

The tests in this study clearly indicated that the food deprivation made the chickens hungrier than at ad libitum feeding. They consumed more food in the food consumption test, they had more food pecks in the novel object test and they were foraging and exploring more in all the tests the longer they had been deprived of food. These were obvious signs of increased hunger. But none of the tests showed any increased stress, frustration or aggression level due to food deprivation. It is possible that it requires an even longer deprivation time before any significant differences in stress, aggression and frustration can be detected among the birds. Other behaviours affected by food deprivation is perching, which decreased the longer they had been without food, and which is related to that the birds spend more time on the ground foraging and exploring. The frequency of comfort behaviours decreased the longer they had been deprived of food. This is correlated to increased foraging and exploring behaviours, that leaves a decreased time budget for comfort behaviours.

Well known domestication effects could be detected in the study where the WL had less perching, foraging and exploring behaviour than the RJF. The results show that WL seem to have lost some of their ability to respond adaptively to food shortage. The WL were also less fearful in the tests, as they had more zone crossings and started to eat faster in the novel object test. The females spent more time foraging and the males were more stressed in the novel object and the open field test. Both of these differences can be explained by the different behaviours male and females have within the flock. The females are foraging while the male watches out for his flock. The roll of protecting and looking out for his females, could also be a reason why the males get more stressed in the test situation.

5.5.1. Conclusions

The results disagreed with the hypothesis that the chickens was going to become more stressed, frustrated or aggressive by food deprivation. They did not become more fearful and the exploring and foraging behaviours were not suppressed. The foraging and exploring behaviours instead increased with deprivation time. As expected, domestication effects were clearly visible, where the RJF were more afraid and the the WL had lost some of their ability to adapt to food shortage. As expected there were also behavioural differences regarding to the sexes, were the females were more social and foraged and explored more and the males were more stressed. Short term food deprivation with a duration of only a few hours can be a useful way to motivate animals in behavioural tests, without having the behavioural motivation systems suppressed by fear, stress or frustration. The outcome of experiments including food deprivation will differ depending on domestication degree and sexes of the animals, which need to be taken in consideration when attending to motivate animal in behavioural tests.
6. Acknowledgements

I wish to thank my supervisors professor Per Jensen and PhD Christina Lindqvist for inspiration and for aiding and guiding me through this journey. Thank you for always taking time for my questions and workings, even during your summer vacation.

Thanks Jan Wretemark for being helpful with everything at Vreta; fixing broken feeding machines, water pipes and other last minute things prior to testing.

And also thanks to Henrik for having patience with me while leaving you to feed chickens on the weekends, writing my report on your vacation and for sometimes talking about nothing but chickens. Thank you for your love and support and for always standing by me.

And I wish to thank Kåre and Inga-Lill for inspiring me to fulfil my aims and goals and for supporting me at all time.

7. References


