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Who is a happy pig?
Does social status affect decision making in a cognitive bias task?

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1 Introduction

Animals are nowadays seen as sentient beings which can experience emotions and express emotional reactions (Boissy and Erhard, 2014). It is hard to appropriately define the term emotion. A very general definition was attempted by Kleinginna and Kleinginna (1981) who define emotion as a complex set of interactions of subjective and objective factors, mediated by neural and hormonal systems, which can give rise to affective experiences, generate cognitive processes, activate widespread physiological processes and lead to behaviour that is often goal directed and adaptive. A more simple definition would be that emotions are specific, intense and short responses to stimuli (Schnal, 2010). This definition also distinguishes emotion from mood which is a longer more ambiguous and nonattributable affective feeling of lower intensity (Schnal, 2010). Emotions and moods both have the two main components a) arousal, which can be high or low and b) the valence, which can be positive or negative (Mendl et al., 2009; Murphy et al., 2014). The concept of the core affect can be visualized in a two-dimensional space (Fig. 1). Positive affective states lie in the right half of the diagram and negative ones in the left half. Simultaneously high arousal states lie in the upper half and low arousal states in the lower half of the diagram(Mendl et al., 2009). This allows to characterize different subjective experiences on the base of these dimensions. The discrete emotion fear for example lies in the quadrant Q4, with a high level of arousal and a negative valence, whereas the emotion calm lies in Q2 as a positive affective state with a low arousal.

This core affect principle reflects the subjective experience of emotions, a direct measure of those subjective experiences is however not possible, especially not in non-human animals since it is not possible to rely on linguistic reports like it is done in humans (Mendl et al., 2009). Nevertheless, as defined by (Kleinginna and Kleinginna, 1981), in emotional states the subjective experience is usually accompanied by behavioural and physiological changes, which can be measured directly in humans and in animals. Physiological measures of emotions are very similar to the research of stress and include for example: measures of HPA-function, changes in heartrate or blood pressure, measures of skin temperature

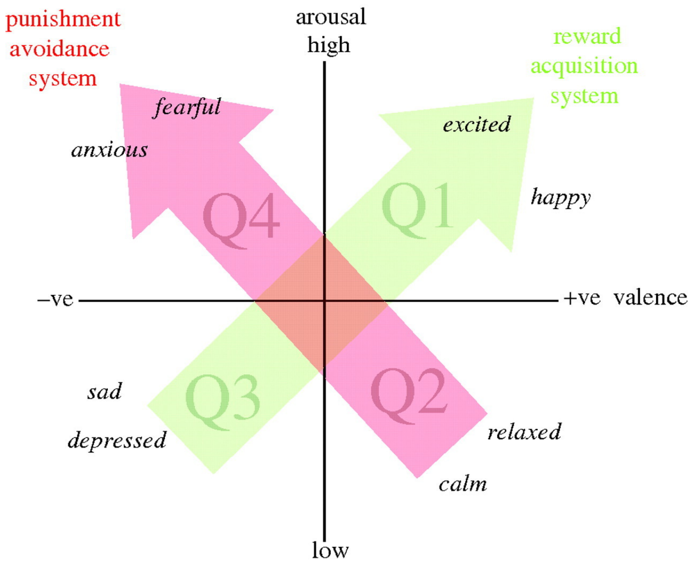

Figure 1: Core affect represented in two-dimensional space. Words in italics indicate possible locations of specific reported affective states (including discrete/basic emotions). Positive affective states are in quadrants Q1 and Q2, and negative states in quadrants Q3 and Q4. Arrows indicate putative biobehavioural systems associated with reward acquisition and the Q3Q1 axis of core affect (green), and punishment avoidance and the Q2Q4 axis of core affect (red) (Mendl et al., 2009).

and other measures of neuroendocrine activity (Paul et al., 2005). The affective terms that are often used in this context are for example anxiety and frustration (Elder and Menzel, 2001). A study on rhesus monkeys for example found a decrease in nasal temperature of individuals in a negative affective state. By using an infrared thermographic system, they could find a significant decrease in nasal temperature during the presentation of a potentially threatening person compared to measurements of temperature before the threatening stimulus. These physiological changes occurred simultaneously with facial expressions which are known to indicate a negative affective state such as the silent bared-teeth face (Nakayama et al., 2005). This study already suggests that behavioural measures can also be used to assess the affective state of an individual. On one hand it is possible to measure spontaneously occurring behaviours such as vocalizations. Adult rats for example elicit ultrasonic vocalizations, which have been believed to be a by-product of locomotor activity. There is however evidence that these vocalizations may index anticipatory affective states, with long low frequencies occurring more often when anticipating punishment and short high frequencies when expecting reward (Knutson et al., 2002). Other spontaneously occurring behaviours, which can be used to measure affective state include for example: facial expressions, approach/avoidance behaviour and play- behaviour (Fraser and Duncan, 1998; Nakayama et al., 2005; Elliot, 2013). On the other hand, especially in non-human animals, behavioural tests are often used to study affective states. A very well-established test mostly used in rodents to assess anxiety, is the elevated plus maze test. For this test, the subject is placed in the middle of four arms of the maze. Two arms of this maze have barriers to the sides and the other two arms are open, so that the subject could fall off it more easily. The activity of the test subject is recorded. The ratio of time spent in open and closed arms can be used as a measure for anxiety behaviour, with more time spend in the open arms indicating less anxiety (Walf and Frye, 2007). Numerous other behavioural tasks have been developed to assess emotional states in a similar manner. Some examples are the forced swim test and especially used in farm animals open field tests and restraint tests (De Pablo et al., 1989; Forkman et al., 2007). However, it is noticeable that most of these behavioural tests focus on negative affective states such as anxiety, fear and depression and generally results should be interpreted with care since problems concerning reliability and validity do exist (Paul et al., 2005; Forkman et al., 2007).

In order to get a more complete picture in the study of emotions, the interaction between cognitive processes and emotions can be investigated. From human psychology research it is known that cognitive processes such as attention, memory and judgement are influenced by emotional states (Baciadonna and McElligott, 2015). This has an adaptive value, since emotions occur in response to stimuli which can be rewarding or punishing and ultimately put the individual respectively in a positive or negative affective state (Mendl et al., 2010). Hence the function of an emotion is to overall enhance the fitness of an individual by mediating the response to said stimulus.

Cognitive bias tests in human psychology

A number of tests have been implemented in human psychology to study the relationship between emotion and different components cognition, all of them can be categorized under the umbrella term of the cognitive bias test. One of those cognitive biases is the memory bias, where individuals in a negative affective state tend to have an elevated ability to retrieve negative memories (Bower, 1981). This was also shown in a study by Burke and Mathews (1992), where patients with a generalized anxiety disorder judged their memory to neutral cue words more consistently with anxious mood than a control group. The second component of cognition which can be influenced by emotion is the attention towards a stimulus. Generally, more anxious people tend shift their attention more towards threatening stimuli (Kindt and Van Den Hout, 2001). This can be shown nicely in the dot probe task, where participants are briefly presented two words on a screen. Afterwards, a dot probe appears at the location of one of those words. It was shown that more anxious people detect the dot probe faster, when it appears as a replacement of a threatening word (MacLeod et al., 1986). The third group of cognitive bias tests used to investigate the interaction of emotion and cognition is the judgement bias test. Emotion affects judgement directly by mediating risk assessment and indirectly through attention and memory alterations (Segerstrom, 2001; Paul et al., 2005). In such judgement bias tasks subjects are usually asked to interpret ambiguous stimuli or make predictions about the future. It has been found that people in a positive affective state tend to report a higher probability for positive events, whereas people in a negative affective state tend to report a higher probability for negative events (Wright and Bower, 1992)). A very interesting study on the interpretation of ambiguous sentences for example was conducted by Eysenck et al. (1991), where they found that more anxious participants interpreted the ambiguous sentences in a threatening manner.

Cognitive bias tests in non-human animals

Such linguistic reports are obviously not possible when trying to adapt these tests for non-human animals. However, most scientists nowadays seem to agree that there are enough parallels between human and animal cognition to be able to research cognitive biases in animals and thereby gain insight into their emotional states (Paul et al., 2005; Mendl et al., 2009). Whether these states are experienced consciously or not can be debated, they do however contain an adaptive function, which makes them very likely to occur in non-human animals (LeDoux, 1998).

All three of the cognitive components mentioned that are affected by emotion have been investigated at least to some extend in animals. The study of emotional effects on attention however has focused again more on behavioural measures than on cognitive ones. Here a commonly used measure is vigilance behaviour, which does usually occur more frequently in threatening situations, as a measure for anxiety-like states (Quenette, 1990; Paul et al., 2005). A study on cattle for example found an attention bias in steers with pharmacologically induced anxiety who were more vigilant towards a presented threat (in this case a dog) than control groups (Lee et al., 2018). Paul et al. (2005) also very nicely suggests adapting the dot probe test for visually oriented species, this has however not been tested so far. Also, the study of the emotional effects on memory in non-human animals faces difficulties. Most studies here focused on the effects of administered stress hormones like glucocorticoids on memory storage and retrieval. The findings are generally that stress hormones enhance memory for the event they are administered before. One day old chickens were for example able to remember a trained avoidance task for a longer period of time than normal when they were administered with corticosterone beforehand (Sandi and Rose, 1994). However, this effect exists for positive, negative and neutral events and therefore enhanced memory might be more of an indicator for emotional arousal than the emotional valence (Hamann et al., 1999; Paul et al., 2005).

The first study which seemed to truly test for emotional valence in animals was the judgement bias task by Harding et al. (2004). Rats were trained in an auditory discrimination task, where they had to learn to press a lever when a tone of a particular frequency was played. If they did so they received a reward. If a tone of another frequency was played, they should learn not to press the lever or else they would receive mild punishment in the form of an unpleasant noise. After training was completed, half of the rats were placed in unpredictable housing, which induces a depression like state in rats and others were kept in the usual housing with no unpredictable events happening. After this phase the responses of the rats to ambiguous non-reinforced frequencies were tested. Rats housed in unpredictable housing responded slower to the ambiguous frequencies and were also less likely to respond at all to the novel ambiguous stimulus. The conclusion of this experiment was that rats housed in unpredictable housing judge ambiguous stimuli less positively because they might anticipate a negative outcome, comparable to depressed humans. Since then various versions of this judgement bias task have been implemented for different species. The general principle however is always that an individual is firstly being trained to discriminate between a cue with a positive outcome and a cue with a negative outcome. In the following test the subject is presented with one or more novel ambiguous stimuli and the response can be interpreted as either positively or negatively biased, depending which response from the training it resembles more (Murphy et al., 2014). The goal is mostly to detect differences between two or more test groups with differing treatments, that should manipulate affective states (Düpjan et al., 2013). This test can for example be used to study the neuronal basis of depression or anxiety. For this purpose, animal models for these kinds of diseases are tested in variations of the judgement bias task. Salmeto et al. (2011) for example used a cognitive bias test to validate the chick anxiety-depression model as a neuropsychiatric stimulation. And also in a study on congenitally helpless rats (an animal model for depression) to investigate the environmental and genetic factors on a negative bias, a negative judgement bias was found in the model which persisted when additional stress was pharmacologically induced (Enkel et al., 2010). Results of negative judgment biases are relatively consistent throughout the literature whether the negative affective states are induced though housing conditions or pharmacologically. Contrarily to other measures mentioned above, the judgement bias test can also be used to asses if an individual is in a positive affective state. This has for example been shown in laboratory rats, where individuals placed in enriched housing after the training phase tended to judge an ambiguous stimulus more positively than rats, which remained in the unenriched cages (Brydges et al., 2011).

Cognitive bias tests in animal welfare research

These findings already suggest that judgement bias tests can also be of a great importance when assessing the welfare of not only laboratory animals but also of farm animals. It is no secret that our farm animals used for mostly meat and dairy production are often housed under poor conditions and have to undergo a lot of stress. The physical and emotional well-being of those animals is of increasing interest of the public and also of politics (Wathes, 2010; Baciadonna and McElligott, 2015). Judgement bias tasks might be an important tool for scientists to asses emotional states of those animals and with that to further improve their well-being (Boissy et al., 2014). Most judgement bias experiments conducted in this field focus on housing conditions and common stressful procedures farm animals have to experience. In the dairy industry, calves for example are separated from their mother earlier than it would be usual under natural conditions. This leads to a more negatively biased judgement towards ambiguous stimuli up to 36 hours after separation (Daros et al., 2014). In another study, dairy cattle calves were tested in a go/no-go touchscreen task before and after the dehorning procedure and it could be shown that the subjects showed a less positively biased judgement towards the ambiguous stimuli at least up to 22 hours after dehorning (Neave et al., 2013). Cognitive bias studies on sheep reveal more conflicting results. On one hand it has been found by Destrez et al. (2013) that chronic stress over the course of 9 weeks leads to a more negatively biased judgement in the tested sheep, which supported the a priori hypothesis. On the other hand, a study which wanted to test the effect of restraint and isolation during sheering, found that restraint and isolated sheep tended to have a more positive judgement bias than the control group (Doyle et al., 2010a). This contrasts to the pre-set hypothesis; however, it might be explained by the fact that sheep were released from the restraint just before the judgement bias test was conducted, which might have put them into a positive affective state (Doyle et al., 2010a). A study on laying hens failed to show a difference in judgement bias between hens housed in enriched housing and hens housed in a basic pen (Wichman et al., 2012). A possible explanation for that might be that the difference between basic and enriched pen was not big enough. For pigs however a difference in judging ambiguous stimuli could be found between piglets housed in enriched housing and piglets housed in a barren environment (Douglas et al., 2012). In this study they successfully used a similar experimental design as (Harding et al., 2004) where piglets firstly were trained to distinguish between two tones of different frequencies, one of them indicating reward and the other one indicating a mild punishment. In the following test, they were presented with an ambiguous tone with a frequency in the middle of the two trainings tones and responses were measured. Another study on pigs, investigating the effect of stocking density and a judgement bias, failed to find significant differences between treatment groups, however a tendency for different learning processes could be observed (Scollo et al., 2014).

Overall the judgement bias test seems to be a promising method to evaluate the effects of different housing conditions and procedures on affective states. What has however not been tested in farm animals is whether such judgment biases can also be affected by more natural factors. It seems likely that different judgement biases might also be apparent under natural conditions since emotions do have an adaptive fitness enhancing value. They might therefore be also elicited during and after social interactions in group living species, where different social relationships have different consequences for fitness (Silk, 2007). Up to date there are only two studies, investigating effects of social interaction on a judgement bias. One of them is a study on Capuchin Monkeys, where the subjects were trained to discriminate between two spatial stimuli, one indicating a small reward and one indicating a big reward. During testing they were presented with an ambiguous spatial stimulus and it was measured whether they anticipated a big or a small reward. Monkeys were chosen for the test based on observations of social behaviour. It was found, that high-ranking monkeys, which received overall more grooming, were more likely to interpret the ambiguous stimuli more positively (Schino et al., 2016). The second study investigating social effects on emotion is a study on bottlenose dolphins. It was tested whether there are individual differences in judging ambiguous stimuli based on differing amounts of socio-positive and socio-negative interactions. Indeed, it was shown that bottlenose dolphins engaging in more socio-positive behaviour tend to have a more positively biased judgement than group members with less socio-positive interactions (Clegg et al., 2017).

Social structure of pig herds, social network analysis

As mentioned above, judgement bias tests were performed on pigs in order to investigate effects of different housing conditions (Douglas et al., 2012). As other farm animals, pigs are highly social animals, naturally living in complex social structures (Keeling, 2001). Given the opportunity, our domestic pigs engage in the same foraging and social behaviour as their ancestor the wild boar (Stolba and Wood-Gush, 1989). Their behaviour and social structure is therefore comparable to wild boars and feral pigs (Stolba and Wood-Gush, 1989). Wild boars live in a matrilineal organization, meaning the social structure is built around a group of sows and their offspring (Graves, 1984). Boars usually disperse in the first year and live solitarily and only join the mother-offspring groups during reproductive periods (Kaminski et al., 2005). The social organization of wild boars and feral pigs also contains hierarchical structures. In the female groups the mother sows are dominant to all other group members and also maintain a linear hierarchy among each other (Mauget, 1981). Not much is known about hierarchies among boars since they live mostly solitarily (Graves, 1984). Only young boars are sometimes seen in small groups; boars over the age of 3 three years live almost exceptionally solitary (Keeling, 2001; Mauget, 1981).

The structure of pig herds is therefore complex and factors such as resource availability and population density might have differing effetcs on indiduals. When analyzing such a social system, commonly used measures such as mating system and group size fail to deliver optimal results since these measures assume homogeneity of effect on all individuals (Wey et al., 2008). A very useful tool for analyzing social structures on all levels is the social network analysis (SNA). "SNA is the study of social groups as networks of nodes connected by social ties" (Wey et al., 2008). This approach explicitly measures relationships between individuals in order to further understand social complexity (Wey et al., 2008). Aside of group measures and intermediate measures (identifying sub-groups), the SNA is able to provide various individual measures to describe an individuals specific position in the network ((Wey et al., 2008). Measures that are taken into account are for example node degree (number of direct ties a focal individual has with others) and the relationship strength (how often does an interaction occur). By using these measures, it is for example possible to quantify the overall importance of an individual in the network, this importance is called "centrality" of the individual. (Friedkin, 1991). While degree centrality only takes into account the number of direct interactions an individual has, betweenness centrality also takes into account the indirect interactions (interactions of the interaction partners) (Wey et al., 2008). Hence this measure tells how important an individual is as a point of social connection (Wey et al., 2008)).

Pigs show a rich behavioural repertoire consisting of agonistic interactions such as fights and displacements (Barrette, 1986) and affiliative interactions such as snout contacts (Stolba and Wood-Gush, 1989). Considering their complex social structure and behavioural repertroire, pigs seem to be a suitable study species to conduct such a social network analysis. What can however not be read directly out of the SNA, is the hierarchy of a herd. As mentioned above pig herds also do contain hierarchical structures, which can be analyzed using a food monopolization test as for example used by Dale et al. (2017) in Wolves. During this test, two individuals are presented with a single food source in a closed area, the dominant individual is then the one which is able to monopolize the food. Such dominance relationships develop in group living species from repeated contests within dyads (Wittig and Boesch, 2003) and usually ritualized signals are used by the submissive to avoid aggression (De Waal, 1986).

Aim of the study, hypotheses and predictions

Social rank and the overall position in the social network might be the main social fitness-relevant factors for group living species. For farm animals, it has however never been tested if and how these factors can affect the affective state of an individual. The aim of this study was therefore to investigate the effect of the position in the social structure on the affective state of a common farm animal, the domestic pig. For this purpose, the social structure of a herd of 39 Kune Kune pigs, held under semi-natural conditions, was firstly observed for a three-month period. Interactions including 6 affiliative interactions and 8 agonistic interactions were recorded in order to create a social network. Afterwards, the social network analysis was conducted focusing on the centrality of the individuals. Additionally, food monopolization tests were carried out to assess the rank of each individual of the herd. On this basis, twenty subjects were chosen counterbalanced for rank, centrality and sex and trained in a spatial discrimination task, where they had to learn to distinguish between a rewarded (positive) and an unrewarded (negative) spatial stimulus (a food bowl presented on either the left or the right side of a closed arena). The subjects were expected to learn to approach the food bowl when positioned on the respective positive side of the arena and not approach the food bowl when placed on the respective negative side of the arena. Finally, these subjects were tested in a spatial judgement bias test, where they were presented with a food bowl on either one of three ambiguous spatial positions in between the two positions from the training phase. Their response towards the spatially ambiguous stimuli was recorded and afterwards analyzed by comparing it to the response to the positive and negative trainings trials. Pigs were expected to show individual differences respective to their social rank and social centrality in the herd. More specifically, we hypothesized that higher ranking individuals judge the spatial ambiguous stimulus more positively than lower ranking ones (Schino et al., 2016). Furthermore, we hypothesized that more socially central individuals also judge the ambiguous stimuli more positively than less central individuals. Since social centrality indicates more social interactions (Wey et al., 2008), central individuals might engage in a richer social life which might put them into a more positive affective state than less socially central individuals (Clegg et al., 2017). A positive judgement of ambiguous stimuli should manifest in approach behaviour towards the food bowls on the spatially ambiguous positions. Simultaneously a negative judgement bias towards the ambiguous stimuli should manifest in not approaching the food bowls at those positions. Lastly, we also expect to see a sex difference. Because of the strongly differing ecology of males and females in pigs, social factors might affect males and females in a different way. More specifically, we expect females to judge ambiguous stimuli more positively, since they generally seem to benefit more from group-living than males.

2 Materials and Methods

2.1 Ethics Note

This study was discussed and approved by the institutional ethics and animal welfare committee in accordance with GSP guidelines and national legislation (ETK-10/10/2018). The subjects of this study participated in the experiments on a voluntary basis and were always rewarded with high value food if they decided to participate. Also, frustration levels of the subjects were kept low by including a high amount of positive reinforcement trials in the test sessions. The present study was non-invasive and stress-free since only behavioural observations were conducted.

2.2 Subjects and Housing

The subjects of this master thesis were 39 Kune Kune pigs from the Forschungsstation Haidlhof of the Messerli Research Institute near Bad Vöslau. The herd lives under semi-natural conditions in an 8ha areal that includes a pasture, a forest, six wooden huts for shelter and a water pit. They feed on grass from the pasture and have ad libitum access to fresh water in drinking dispensers. Additionally, they are fed once a day with a mixture of corn, bread, vegetables and fruit. The oldest pigs are the three mother-sows, from which the rest of the herd descends. These sows are now 5 years old. They had their first offspring in 2014 and then a second litter in 2015. Subsequently the herd now consists of 39 adult pigs (20 females and 19 males) with ages ranging from 3 to 5 years. All the boars were made infertile by vasectomy, which means they are able to display their natural behaviour as boars. The pigs establish their own hierarchy and social structure in which also the mother sows are fully integrated.

2.3 Social Network Analysis

2.3.1 Data collection

Because a social network analysis is connected with a high time and effort investment, this part of the master thesis was executed by me and another master student. The work effort for data collection and video coding was split equally between the two experimenters. The experiment specific analysis, regarding social centrality were then again carried out only by me.
We constructed a social network of the herd using two different methods of recording, the first one being scan sampling. Here we scanned the whole herd 4-6 times per day with minimum one hour between scans. Using a video camera, we walked approximately the same path every time over the whole areal until every pig was recorded. Using the video camera also as a voice recorder, all the information possible was spoken on the tape (name of the pig that could be seen, context, names of the neighbor pigs). The second recoding method used for the social network, was ad libitum sampling, which was carried out in between scans. Again, using video cameras, we observed the pigs this time just randomly in their enclosure and recorded every interaction between individuals we could observe. The data collection for the social network analysis was conducted between the 1st of June 2018 and the 15th of August 2018. Data was collected on 5-6 days of the week during 7:30am and 16:30pm. One month prior to data collection we stared to interact with the pigs and learn to distinguish between individuals. Furthermore, the pigs are habutated to humans since they are born. While recording interactions, a safe distance of approximately 3 meters was kept in order to ensure not to disturb the animals in their natural behaviour.

2.3.2 Video Analysis

In total we recorded 103 scan videos and 513 ad libitum videos. Scans were mainly used to collect proximity data. For that we analyzed grouping of the pigs, which means, pigs that foraged or rested within approximately one pig-length of each other, were recorded as one group. Also, we recorded the nearest neighbor of each pig within the group. If a pig was resting or foraging alone it was recorded

Table 1: Affiliative and agonistic interactions coded for the social network analysis with their respective definitions

Behaviour	Definition
Affiliative	
Greeting	vocalisation, touching the other's snout; sometimes also prodding, but only at each other's head
Snuffling	sniffing parts of each other's head
Touching	direct contact of two pigs between the pigs snouts and other body regions
Co-feeding	eating next to each other at the feeding ground not more than a radius of the individual's head apart
Co-foraging	looking for food next to each other or even eating next to each other at the fodder meadow, not more than a body length apart
Co-resting	pigs lie next to each other, with body contact
Agonistic	
Displacement without body contact	rapid movement of the head of pig A towards pig B; pig B runs off; also pig B runs off, when pig A comes near; sometimes vocalisation
Aggressive displacement without body contact	(fast) direct approach of pig A towards pig B, pig B runs off
Displacement with body contact	pig A displaces pig B with prodding, pushing, biting; pig B runs off
Threatening	two pigs walk shoulder to shoulder, each pig trying to be the strongest
Gnashing of teeth	grinding with the teeth and foaming, sometimes also vocalisation
Fighting	pig A and pig B are pushing, biting, scratching each other and sometimes there is also a vocalisation
Chasing alone	pig A runs after pig B
Chasing in group	more than one pig run after one individual either with or without vocalisation and/or biting

as a group for itself and also did not have a nearest neighbor. Also, we noted the location of every pig in the enclosure (e.g. hut, meadow, forest, feeding site) and the context (foraging or resting). If possible, we also coded interactions that we were interested in during scan videos. Primarily we coded interactions via the ad libitum recordings though. We were interested in affiliative, agonistic and mating related interactions. Affiliative interactions include: greeting, snuffling, touching, co-feeding, co-foraging, co-resting. Agonistic interactions that were coded are: displacement without body contact, aggressive displacement without body contact, threatening, gnashing of teeth, fighting, chasing alone, chasing in group (for definitions see Fig. 1). For the sake of completeness we also coded mating related interactions; these include: sniffing, following, scenting, scent marking, scenting while another male is copulating, prodding, testing, mounting, copulating and finally also grouping behaviour of the pig herd was coded (for definitions see Fig. 2). The ethogram we used was adapted from Koglmueller (2016) and Nestelberger (2018). Finally, all data was coded by hand using VLC media player and transferred into an excel sheet.

Table 2: Mating related and grouping behaviours coded for the social network analysis with their respective definitions

Behaviour	Definition
Mating-related	
Sniffing	pig sniffs at another's bottom
Following	male is running or going after the female
Scenting	pigs sniff at each other's snout; the male is foaming; without vocalization
Scent marking	pig is setting a mark by rubbing the forelegs on the ground
Scenting while another male is copulating	males are foaming and sniff at the female's head while another male is copulating
Prodding	males prod or push the female's head and/or abdomen
Testing	pig is trying to mount another individual
Mounting	pig A climbs on pig B's back; pig B is standing still; without copulation
Copulating	male mounts female and inserts penis into the sow's vagina
Grouping	
Grouping	pigs are in the same distance to each other and/or moving in the same direction; standing as well as feeding; both at the meadow and in woods
Grouping during resting	lying next to each other, not more than approximately one body length or width apart

2.3.3 Reliability Test

Since the social network analysis was conducted by two experimenters, we did an inter-observer reliability-test using Cohens-Kappa alpha as a measure for reliability. The two experimenters coded the same 10 scan videos for grouping of the pigs and 50 interactions from ad libitum videos. Cohens-Kappa for grouping in the scan videos was 0.85 and for interactions in the ad libitum videos was 0.93. This means the level of agreement was strong in the case of coding the grouping behaviour in scans and almost perfect for coding interactions.

2.3.4 Data Analysis

The social network analysis was conducted with the help of Ferenc Jordan (2018, Budapest) using the software CoSBiLab Graph (Valentini and Jordán, 2010). Since for this study socially central and loner pigs were important, the centrality data out of the affiliative and the agonistic network was used in order to choose subjects for the judgement bias task. The measure used for centrality was the Wi-Index. This index considers the two interaction partners, the frequency of interactions, and also the second-degree partners of the two interacting pigs (Wey et al., 2008). This means, a pig with a high Wi-index has a lot of interactions, with a lot of other pigs, who also have a lot of interactions with other pigs and can therefore be considered a very central pig of the herd. Wi-Indices were calculated for each pig in an affiliative network including six affiliative interactions and in an agonistic network including 8 agonistic interactions. Afterwards I added the two respective values for each pig to receive a general centrality index including all interactions. The images of the networks were created using Netdraw (Borgatti et al., 2018) and visualized with the layout "Spring Embedding", this allows central individuals to be clustered in the middle of the network and less central individuals more to the periphery, while also minimizing the crossing of arrows. As we noticed that females in general had significantly lower values than males, females and males were separated. In order to group the subjects, individuals with a wi- index higher than the median of the herd were considered centrals and individuals with a Wi-index lower than the median of the herd were considered loners.

2.4 Hierarchy Tests

Since we wanted to choose the subjects for the cognitive bias test not only based on centrality data, but also on the rank, hierarchy tests were conducted. For this purpose, we used a food monopolization test. The tests were carried out in an outdoor arena (5.20m x 4.70m) with two adjacent waiting compartments. Through the fences of the waiting compartments the two subjects could see each other. They were however, visually separated from the rest of the herd.

For the test, the two subjects were guided each into one of the waiting compartments and a food bowl with a few pieces of high value food (bread and apples) was placed right into the middle of the arena. Firstly, each pig was let into the arena alone and was able to eat the food out of the bowl, for them so see that there is a food source in the arena. Then, both pigs were let into the arena at the exact same time and it was noted which pig was able to monopolize the food. Here it is important to note, that not the pig, who reached the bowl first was the winner, but the pig that was able to displace the other pig and monopolize the food at the end. This procedure was carried out three times in a row and the pig that was able to monopolize the food bowl for at least two times was noted as the higher-ranking pig.

2.4.1 Rank analysis

Based on this data, for each pig a hierarchy index was calculated. For that, we constructed a pivot table pairing each individual with every other individual of the herd of the same sex. For the hierarchy we separated males and females since females in general are always lower ranking than males in pigs. If an individual won the food monopolization test against the partner we noted 1 in the table if it lost, we noted 0. At the end all values in one row were added. This value then served as the hierarchy index of the respective pig. Note that, some pigs have the same values, because pig hierarchies are not linear, and loops do occur frequently. Also, here for splitting the subjects into groups, pigs with a rank index higher than the median of the herd were classified as high ranking individuals and pigs with a rank index lower than the median of the herd were considered low ranking individuals.

Table 3: Table of the subjects which participated in the cognitive bias task. Each with the respective sex, the rewarded side, the position in the network with index and the rank with index.

name	sex	reward side	social position	centrality index	rank	rank index
Zeus	m	L	central	8.44	high	12
Zeppelin	m	R	central	31.49	high	14
Rudi	m	L	central	4.2	high	13
Benjamin	m	R	loner	3.54	high	10
Bruno	m	L	loner	3.87	high	10
Zardoz	m	R	loner	2.97	low	4
Bolero	m	L	loner	1.48	low	5
Barbarossa	m	R	central	4.12	low	5
Zoltan	m	L	loner	1.64	low	5
Zazou	m	R	loner	3.57	high	15
Zora	f	R	central	3.54	high	19
Zafira	f	L	central	4.28	high	17
Rosine	f	R	loner	1.23	low	7
Bella	f	L	central	3.81	low	6
Blossom	f	R	loner	1.52	low	2
Rubina	f	L	central	3.76	low	3
Bijou	f	R	loner	1.69	high	11
Rapunzel	f	L	central	3.03	high	14
Beauty	f	L	loner	1.75	high	18
Belana	f	R	loner	1.96	high	9

2.5 Cognitive Bias Test

2.5.1 Subjects

A spatial discrimination cognitive bias test was conducted with 20 pigs from the herd. Within the subjects we counterbalanced rank, centrality, and sex. Also, the general motivation to participate in the task and the health status of the pigs was considered. In the end, twelve high ranking individuals, eight low ranking individuals, nine central individuals and eleven loners could be tested (Fig. 3).

2.5.2 Experimental Setup

The test was conducted in an arena that was built out of metal fences, covered with green plastic tarp as visual cover. The arena (5 x 5m) was accessible through a door (60cm) right in the middle of the front side. Pigs had to enter the arena through two adjacent waiting compartments (1.92 x 2m). The first waiting compartment had an opaque barrier to the second waiting compartment and served for separating the pig from the herd and for visually separating the subject when the food bowl was baited. From the first waiting compartment, the pigs could enter the second one through a door. The second waiting compartment had no opaque barrier on the side adjacent to the arena, this gave the pigs the possibility

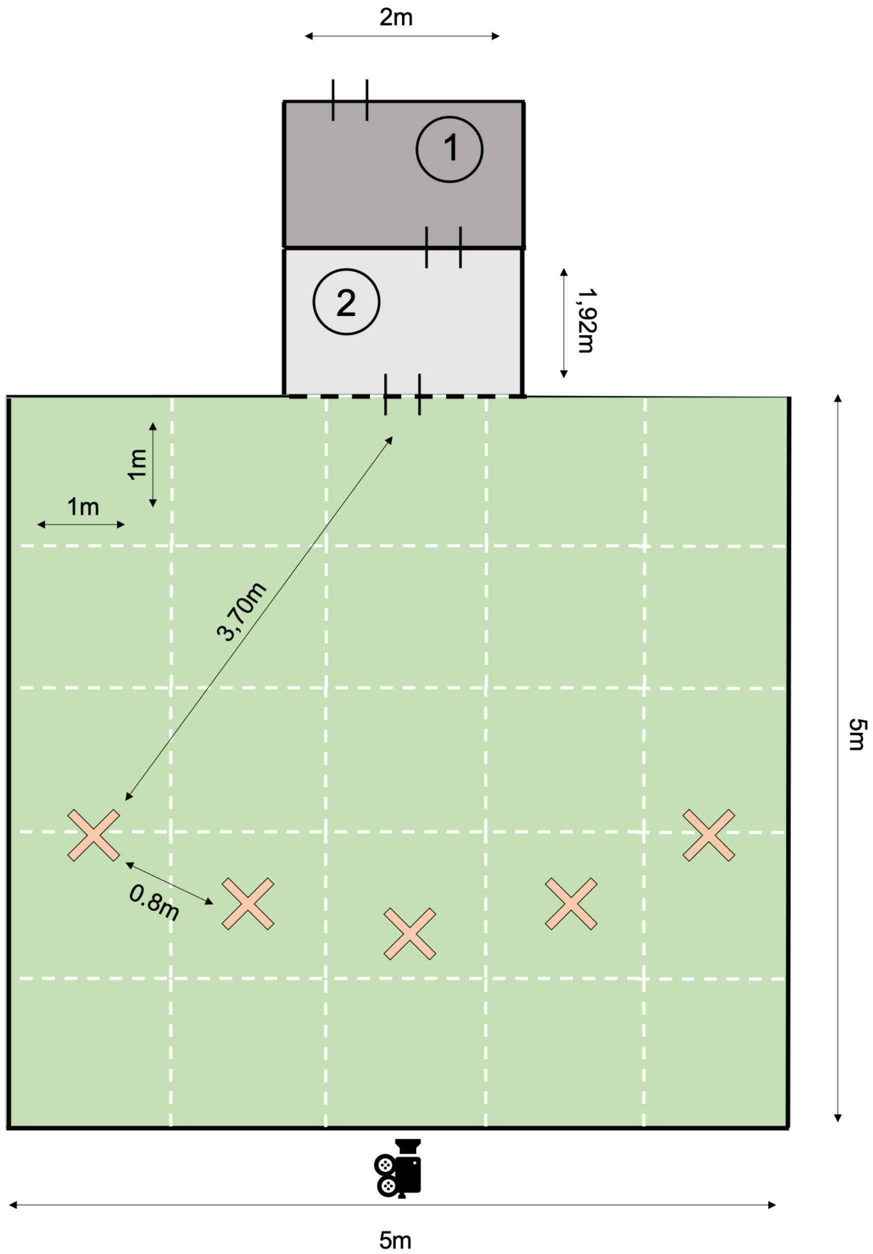

Figure 2: Topview of the experimental setup. First waiting compartment (1.92x2m) with opaque barriers to seperate the pig. Second waiting compartment (1.92x2m)with an open fence to the side of the arena. Arena (5x5m) with a grid (1x1m) on the floor and five markings for possible positions for the food bowl. Thick black lines indicate metal fences with opaque barriers, dotted black lines indicate metal fences without an opaque barrier. The two small parallel black lines stand for doors (60cm wide) to enter the waiting compartmens/the arena. The white dotted lines represent the grit on the floor of the arena and the red crosses indicate the five possible positions for the food bowl.

subject	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bolero	P	P	N	N	P	N	P	P	N	P	N	N	P	N	P

Figure 3: An exaple of the trials of one training session, in this case for the subject Bolero. "P" stands for a positive trial, "N" for a negative one. The orange boxes represend the fixed positive trials at the beginning and the end of the session for motivation

to have an overview over the inside of the testing arena from the waiting compartment. In the arena five potential positions for food bowls were marked. All the positions had the same distance to the middle of the entrance door (3.70m) and were 80cm apart from each other. Also, the far left and the far-right position had at least 80cm distance from the outside walls of the arena (Fig. 2). The ground of the arena was covered in a green plastic tarp with white markings of 1x1m squares, which could afterwards be used for analyzing the chosen path of the pigs to the food bowls. Outside the arena, on the opposite side of the entrance door, a network camera (Axis M1125) was mounted on a long wooden beam so that the whole arena and the second waiting compartment were visible from above on the video recording.

2.5.3 Training

Before starting the testing-phase, pigs had to show clear responses in the trainings-trials. For training, only the far left and the far right position for the food bowl were used. The sides were counterbalanced. This means that, 10 randomly picked pigs were trained to expect a reward if the food bowl was placed on the far left position of the arena and the other 10 pigs were trained to expect food when the bowl was placed on the far right position of the arena. One training session consisted of 15 trials, out of which the first two and the last one were always rewarded trials in order to motivate the pigs. The rest of the trials, positive and negative followed in a pseudo random order with the criterion, that there were never more than two negative or two positive trials in a row (Fig. 3).

This served for keeping motivation of the pigs high and making sure that negative and positive trials were around equally distributed in one session. At the beginning of each session, the pig was called from the pasture, lured into the first waiting compartment with one piece of bread and with that separated from the herd. After that the session could begin. For a positive training trial, the food bowl was filled with a few pieces of apple and bread and placed on the respective positive side for the subject and covered with a lid to avoid visual cues. The individual, waiting in the first compartment, was let into the second waiting compartment. Three seconds after the pig reached the entrance door to the arena (from where it could already look into the arena), the door was opened, and the pig could walk towards the food bowl. For reaching the food, it had to open the lid. Then it was allowed to eat the reward. After finishing the food in the bowl, the pig was called back into the second waiting compartment and from there into the first waiting compartment and rewarded with one piece of bread. There it had to wait for the next trial. After a few sessions of training, the pigs learned to return into the waiting compartments without being called back, after they finished the food. Nevertheless, they always received a reward (one piece of bread) after entering the first waiting compartment.

For a negative trainings trial, the food bowl was empty and placed on the respective negative position for the subject and also covered with a lid. To additionally avoid scent cues, always the same food bowl was used for positive and negative trials so that there was always still a bit of apple juice in the bowl. Again, the subject was let into the second waiting compartment and the door to the arena was opened after three seconds. The pig was allowed to walk to the food bowl, open the lid and check out that it was empty. After that the pig was also called back into the second waiting compartment and then into the first one where again it received a reward and had to wait for the next trial. After a few negative trainings-trials the pigs have learned, by trial and error learning, that it was not worth approaching the food bowl or opening the lid when it was placed on the negative side of the arena. A negative trainings trial was considered successful when the pig did not approach the empty food bowl or did not open the lid but return right back into the second waiting compartment without having to be called back. Again, it received a reward when it entered the first waiting compartment.

subject	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bolero	P	P	N	M	P	N	P	NN	N	P	N	NP	P	N	P

Figure 4: An exaple of the trials of one testing session, in this case for the subject Bolero. "P" stands for a positive trial, "N" for a negative one, "M" stands for the middle position, "NP" for the near positive position, and "NN" for the near negative one. The orange boxes represend the fixed positive trials at the beginning and the end of the session for motivation and the green boxes indicate the fixed trial positions for the ambiguous cues

2.5.3.1 Training Criterion The pigs proceeded from the training into the testing phase after they reached the preset criterion of making not more than two mistakes (one positive, one negative were allowed) within two consecutive training sessions, with sessions not being longer than 4 days apart from each other. Tests started 48 hours after the pig reached the training criterion.

2.5.4 Test

A tes session also consisted of 15 trials, with the first and the last trial always being a positive one to keep motivation high during the test phase. During one test session, the three middle positions (near positive, middle, near negative) for the food bowl were introduced as ambiguous cues in between trainings/reinforcement trials. Each one of those positions was used once per testing session in a random order, on their fixed trial position. Test trials in one session were always trial four, eight and twelve (Fig. 4).

The ambiguous cues in the test trials were never rewarded. Also, for these trials the procedure was exactly the same than in the training trials. The pig was led from the first waiting compartment into the second and was allowed to enter the arena three seconds after reaching the entrance door. A test trial was considered terminated when the pig returned into the waiting compartment without having to be called back. There it again received one piece of bread as a reward. The rest of the trials were reinforcement trials, where the positive and the negative position were pseudo randomly distributed as in the training with the criterion that not more than two negative or positive trials followed in a row. Each pig went through three test sessions, with always 48 hours between sessions.

2.5.5 Video Analysis

The videos of the test sessions were analyzed by hand in VLC player and the data was transferred into an excel sheet. Parameters that were coded were: "approach the food bowl "l, "open lid of the bowl". For coding approach, I constructed a 50cm large radius around each food bowl on the video. If the pig entered the radius it was coded as 1 of not the value was 0. Open lid was coded in the same way. 1 was entered for opening the lid 0 for not opening. If the pig did not approach the bowl, open lid was automatically 0. For the general "positive response" both of these responses were considered.

2.6 Statistics

The statistical analysis was conducted with the help of Roger Mundry (2019, Vienna). To test what influenced the probability of a positive response, we used Generalized Linear Mixed Models (Baayen, 2008) with binomial error structure and logit link function (McCullagh & Nelder 1989). In all models, the response was whether the individual showed a positive response (no, yes). In a first model we addressed whether rank and social centrality influenced the probability of a positive response and whether this influence was varying between sexes. Hence, we included as fixed effects: rank and social centrality and their interactions with sex (and also sex as a main effect). Furthermore, we controlled for session number and the side at which the reward was placed in the training by including them as additional fixed effects. As random intercepts effect we included the identity of the individuals tested. To keep type I error rate at the nominal level of 5% we included a random slope (Barr et al. 2013; Schielzeth H & Forstmeier W. 2009) of session number within individual. Since our main interest was in the effects of rank and social centrality and since we wanted to avoid cryptic multiple testing (Forstmeier & Schielzeth 2011) we compared this full model with a null model lacking these two terms and their interactions with sex but being otherwise identical. For this comparison we used a likelihood ratio test (Dobson, 2002). The model was fitted in R (Version 3.6.1, R Core Team 2019) using the function glmer of the package lme4 (Version 1.1-21, Bates et al. 2015). Prior to fitting the model, we inspected the distributions of rank and social centrality and since social centrality was very skewed, we log transformed it. After that we z-transposed rank, social centrality and session number to a mean of 0 and a standard deviation of 1 to ease model convergence and achieve comparable estimates. Collinearity assessed via inspection of Variance Inflation Factors (Field 2005) obtained from a standard linear model lacking the random effects appeared to be no issue (maximum VIF: 1.41; function vif of the R package car; version 3.0-3; Fox & Weisberg 2019). The sample size for this model was 60 observations of 20 individuals and the response conveys the response of 30 total responses. Given the small sample size and the low number of positive responses and the relatively complex model it was obvious that the power of this model would be very low. Hence, we decided to fit two separate models, one lacking rank and its interaction with sex and one lacking social centrality and its interaction with sex, to investigate the effects of social centrality and rank respectively. We estimated stability of these two models by excluding individuals one at a time and comparing the estimates derived for models based on these subsets of the data with those obtained for the full data set. Tests of individual effects we based on likelihood tests comparing a given model with models dropping the effects under consideration one at a time.

Table 4: Table of Wi-indices from the affiliaive network. Males and females are seperated. The individials in grey are the test subjects.

males

name	ID	Wi affiliative
Zampano	Z3	3.75
Zacharias	Z1	3.3
Baldur	B7	2.53
Zeppelin	Z10	2.49
Radomir	R7	2.44
Zazou	Z4	2.33
Zardoz	Z9	2.27
Benjamin	B2	2.12
Bruno	B13	1.86
Zerberus	Z5	1.83
Zeus	Z11	1.68
Zafran	Z8	1.67
Zoltan	Z14	1.64
Rudi	R5	1.55
Romeo	R3	1.54
Ronon	R9	1.48
Barbaross	B8	1.24
Bolero	B12	1.16
Rasputin	R2	1.08

females

name	ID	Wi affiliative
Bernadette	B10	2.67
Zita	Z13	2.41
Zora	Z0	2.34
Radieschen	R6	2.08
Zoey	Z6	2.04
Belana	B9	1.96
Zwetschge	Z7	1.84
Rapunzel	R1	1.83
Bessy	B3	1.74
Bibi	B4	1.74
Blume	B6	1.69
Blossom	B11	1.52
Rubina	R11	1.51
Bijou	B5	1.49
Zirbe	Z12	1.42
Beauty	B0	1.25
Rosine	R10	1.23
Bella	B1	1.18
Zafira	Z2	1.17
Raya	R8	1.01

3 Results

3.1 Social network analysis

Two centrality networks were constructed. One for affiliative interactions including 6 behaviours and one for agonistic interactions including 8 observed behaviours. Within each network, each individual has a specific index (Wi-index) regarding its centrality in the netwok. High numbers of wi indicate a central pig and low values for Wi indicate a loner individual.

3.1.1 Affiliaitve network

In the affiliative network, Wi-indices range from 1.08 until 3.75 for males (mean=2, SD=0.70) and from 1.01 until 2.67 for females (mean=1.70, SD=0.45). Females in general have slightly lower values than males. In general, the Wi-index values in die affiliative network do not have a big variation between males and females and within the sexes. The most central male in the affiliative network is Zampano (Wi=3.75) and the most central female is Bernadette (Wi=2.67). Rasputin (Wi=1.08) (m) and Raya (Wi=1.70) (f) are the least central individuals for both sexes (Fig. 4).

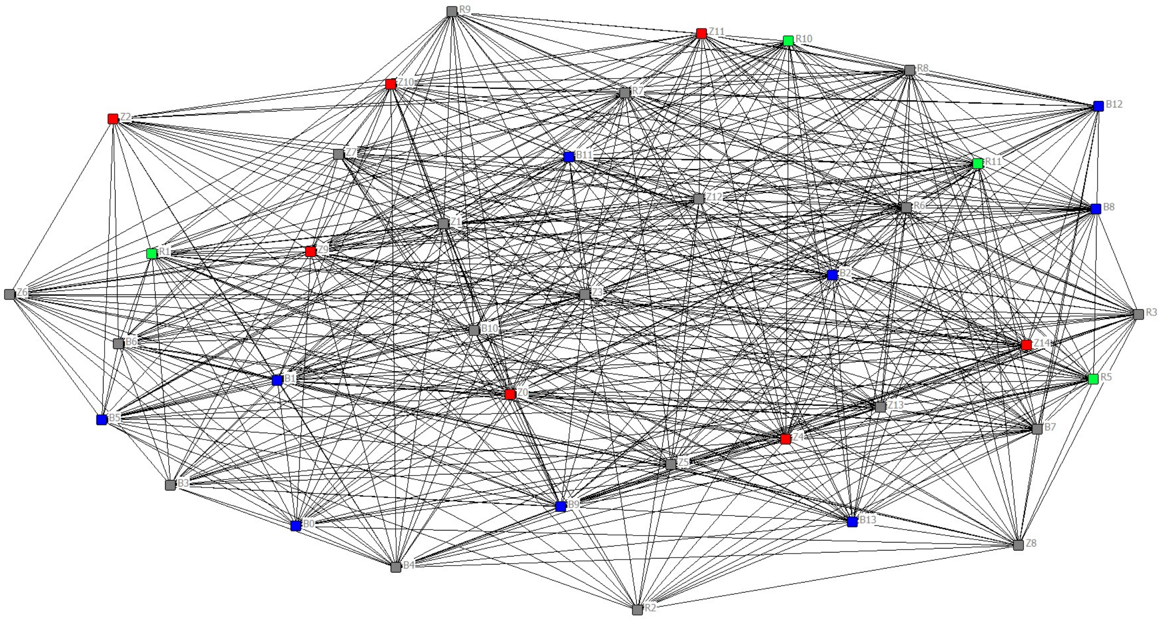

Figure 5: The drawing shows the complete affiliative network of the whole herd, including 6 affiliative interactions. The squares indicate individuals of the herd with their respective abbrevations,the grey lines indicate interactions. Coloured squares indicate the test subjects. The different colours indicate the different families the individuals belong to (Individuals with R as the first letter of their name descend from the sow Ronja, the individuals with B as their first letter descent from the sow Beauty and individuals with a Z as their first letter of the name are the offspring of Zora).

The social network analysis for affiliative interactions shows are very dense network, with all pigs of the herd included, where even pigs with a lower centrality index still have a considerable amount of affiliative interactions to other pigs. Zampano (Z3) is the most central pig of this network, receiving and sending the most affiliative interactions with the highest number of other group members. Less central individuals here are for example Raya (R8), Zafira (Z2), Bolero (B12) and Rasputin (R2) Fig. 5).

3.1.2 Agonistic network

In the agonistic network, the Wi-indices range from 0 to 29 for males (mean=3.78, SD=6.73) with Zeppelin (Wi=29) being the most central pig and Zoltan (Wi=0) not having any observed agonistic interactions. For females the indices range from 0 to 3.11 (mean=0.82, SD=0.96). Here Zafira (Wi=3.11) is the individual with

Table 5: Table of wi-indices from the agonistic network. Males and females are seperated. The individials in grey are the test subjects.

males			females		
name	ID	Wi agonistic	name	ID	Wi agonistic
Zeppelin	Z10	29	Zafira	Z2	3.11
Zacharias	Z1	11.94	Bella	B1	2.63
Zeus	Z11	6.76	Rubina	R11	2.25
Zerberus	Z5	4.13	Zwetschge	Z7	1.63
Barbarossa	B8	2.88	Bibi	B4	1.25
Zampano	Z3	2.69	Rapunzel	R1	1.2
Rudi	R5	2.65	Zora	Z0	1.2
Ronon	R9	2.31	Bessy	B3	1.03
Bruno	B13	2.01	Blume	B6	1
Benjamin	B2	1.42	Beauty	B0	0.5
Zazou	Z4	1.24	Zoey	Z6	0.25
Baldur	B7	1.23	Bijou	B5	0.2
Radomir	R7	1.18	Radieschen	R6	0.13
Romeo	R3	0.78	Raya	R8	0.08
Zardoz	Z9	0.7	Zita	Z13	0
Rasputin	R2	0.42	Belana	B9	0
Bolero	B12	0.32	Zirbe	Z12	0
Zafran	Z8	0.08	Bernadette	B10	0
Zoltan	Z14	0	Rosine	R10	0
			Blossom	B11	0

the highest value and Zita (Wi=0), Belana (Wi=0), Zirbe (Wi=0), Bernadette (Wi=0), Rosine (Wi=0) and Blossom (Wi=0) the lowest. In this network the difference between males and females is much higher. For females the values are more similar to the affiliative network. For males however, the Wi-index values are much higher and have a much bigger variation (Fig. 5).

The social network constructed out of the agonistic interactions is less dense, meaning that there were in total less agonistic interactions observed during the time of the data collection. The most central pig of the herd for agonistic interactions is Zeppelin (Z10, Wi=31.49). Less central individuals here are for example Raya (R8, Wi=1.09) and Rosine (R10, Wi=1.23) (Fig. 6).

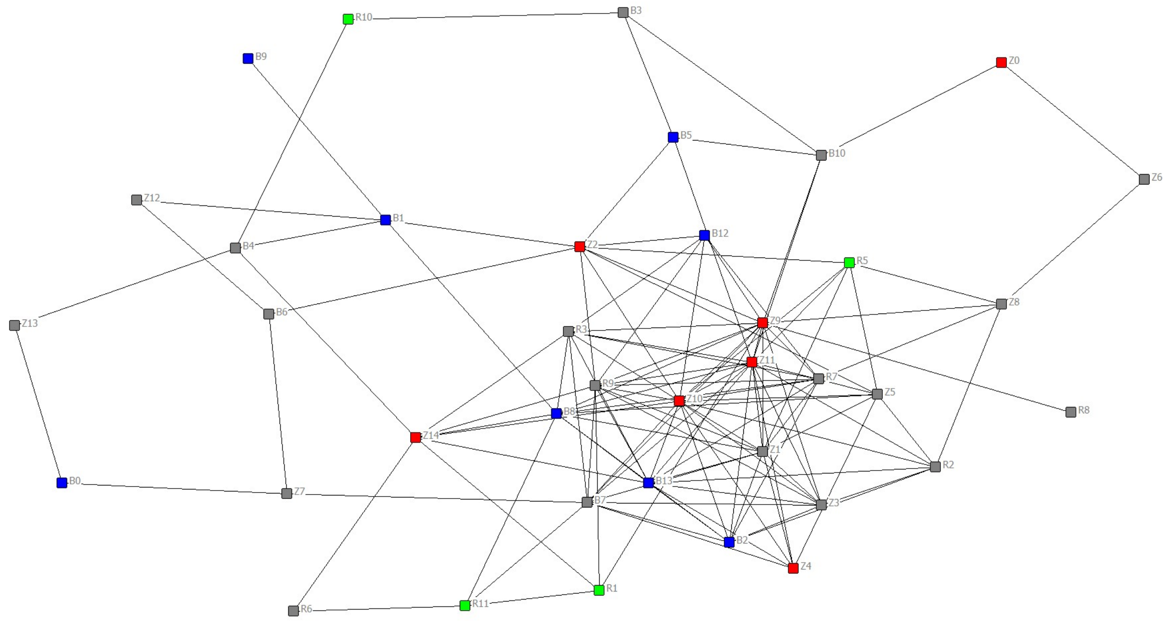

Figure 6: The drawing shows the complete agonisitc network of the whole herd, including 8 agonisitc interactions. The squares indicate individuals of the herd with their respective abbrevations,the grey lines indicate interactions. Coloured squares indicate the test subjects. The different colours indicate the different families the individuals belong to (Individuals with R as the first letter of their name descend from the sow Ronja, the individuals with B as their first letter descent from the sow Beauty and individuals with a Z as their first letter of the name are the offspring of Zora).

Table 6: Table of overall social centrality values derrived from the affiliative and agonistic network. Males and females are seperated. The individials in grey are the test subjects.

males			females	
name	centrality index		name	centrality index
Zeppelin	31.49		Zafira	4.28
Zacharias	15.24		Bella	3.81
Zeus	8.44		Rubina	3.76
Zampano	6.44		Zora	3.54
Zerberus	5.96		Zwetschge	3.47
Rudi	4.2		Rapunzel	3.03
Barbarossa	4.12		Bibi	2.99
Bruno	3.87		Bessy	2.77
Ronon	3.79		Blume	2.69
Baldur	3.76		Bernadette	2.67
Radomir	3.62		Zita	2.41
Zazou	3.57		Zoe	2.29
Benjamin	3.54		Radieschen	2.21
Zardoz	2.97		Belana	1.96
Romeo	2.32		Beauty	1.75
Zafran	1.75		Bijou	1.69
Zoltan	1.64		Blossom	1.52
Rasputin	1.5		Zirbe	1.42
Bolero	1.48		Rosine	1.23
			Raya	1.09

3.1.3 Social centrality

For receiving a value for an overall social centrality (including all interactions) of the herd, we added the two values from the affiliative and the agonistic network. In males also here Zeppelin has the highest index with a value of 31.49. The least central male was Bolero with a centrality index of 1.48. The average index of centrality for males was 5.77 (SD=6.99). Since Zeppelin has an exceptionally high value in the group, the median of 3.76 might be a more reliable value in this case. For females the most central individual was Zafira with a value of 4.28. The female individual with the lowest centrality index was Raya with a value of 1.09. The average index of overall centrality for females is 2.53 (SD=0.93). Since the centrality index values for females are much more evenly distributed the median of 2.54 does not differ much from the mean value (Fig. 6).

Table 7: Table of the hierarchy derived from the food monopolization test. Males and females are seperated. The numbers indicate the rank indices and the individuals in grey are the test subjects.

males		females	
name	rank index	name	rank index
Zacharias	18	Zora	19
Zampano	17	Beauty	18
Zerberus	16	Zafira	17
Zazou	15	Zoe	16
Rudi	13	Zwetschge	15
Zeppelin	14	Rapunzel	14
Zeus	12	Blume	13
Benjamin	10	Bibi	12
Bruno	10	Bessy	11
Rasputin	10	Bijou	11
Radomir	8	Belana	9
Romeo	6	Bernadette	8
Barbarossa	5	Rosine	7
Bolero	5	Bella	6
Zoltan	5	Raya	5
Zardoz	4	Zita	3
Ronon	4	Radieschen	3
Zafran	2	Rubina	3
Baldur	0	Blossom	2
		Zirbe	1

3.2 Hierarchy

According to the food monopolization tests, a hierarchy was created with indices for each pig of the herd. The rank index basically depicts "how many individuals are below the subject"(Fig. 7). In the males, Zaccharias has the highest value with 18 and Baldur was the lowest ranking male at the time of the experiments. Especially in the middle of the hierarchy there are some pigs with the same values. For example, Rasputin, Bruno and Benjamin all have the same rank index of 10. This is because pigs dont have a linear hierarchy and loops do occur frequently. The highest ranking female during the experiments was Zora with a rank index value of 19. Zirbe was the lowest in rank with a value of 1. This is also because there is a loop in the hierarchy. Also, in females some have the same amount of individuals underneeth them and therefore the same rank index, for example Zita, Rubina and Radieschen all have 3.

Table 8: This table shows the training sessions conducted until the respective individual reached the pre-set training criterion and was able to proceed to the testing phase.

ID	sessions until criterion
Bolero	5
Blossom	4
Rubina	3
Rapunzel	4
Zeppelin	9
Zardoz	7
Rudi	8
Zora	8
Rosine	9
Barbaross	5
Beauty	5
Belana	5
Bella	4
Benjamin	4
Bijou	4
Bruno	4
Zafira	4
Zazou	4
Zeus	4
Zoltan	5

3.3 Cognitive bias test

3.3.1 Training

Before proceeding to the test phase, each individual had to reach a pre-set training criterion. The fastest individual to learn the task was Rubina, who reached the criterion only after three sessions. Rosine and Zeppelin had to participate in the most training sessions with a number of 9 sessions (Fig. 8). On average the subjects learned to successfully discriminate between rewarded and unrewarded side of the arena in 5.52 sessions (SD=1.86).

3.3.2 Test

To analyze whether the paradigm overall worked as expected, the mean response of all subjects over all three test sessions for each bowl positions was plotted in a bar graph. All individuals show a positive response towards the positive bowl position from the training and on average only 6% show a positive response to the negative stimulus. This shows us that the training was successful. For the near positive position, they show almost equally as much positive responses

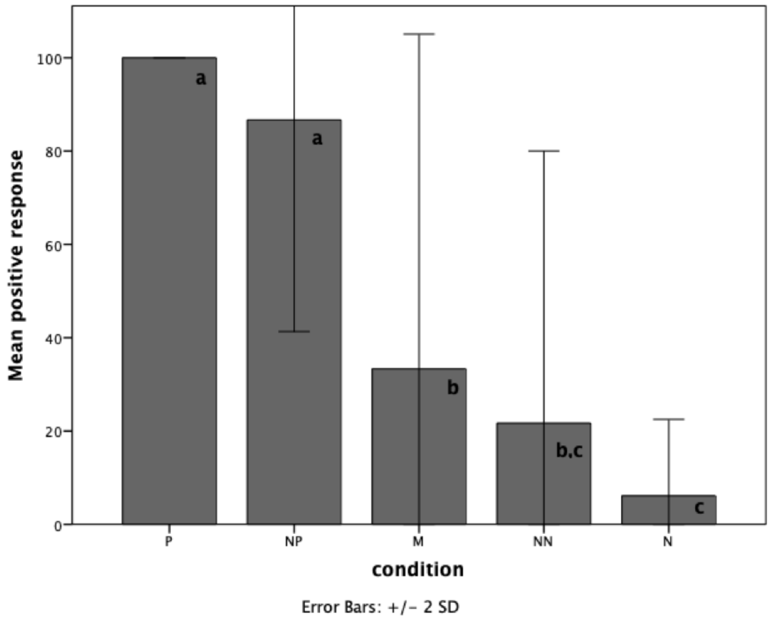

Figure 7: This figure shows the mean responses to all conditions of all test subjects over all three test sessions with standartdeviation +/- 2SD. The x-axis shows the five different postions of the food bowl (P=positive, NP=near positive,M=middle, NN=near negative, N=negative), the y-axis shows the mean percentage of positive responses for each pig over all three sessions.The letters in the bars indicate which goups differ significantly from each other and which do not (Chi^2=707.785, df=4, p >0.001).

than for the positive position, namely 87%. For the middle position the mean positive response is 33% and for the near negative 21%. As expected, we can see a decrease of positive response over the three ambiguous positions from the near positive position over the middle position to the negative postition (Fig. 7).

The response to the near positive position (NP) does not differ significantly from the response to the positive position (P) and the near negative position (NN) does not differ significantly from the negative position (N). Hence, NP and NN can not be considered ambiguous spatial stimuli for the pigs. Only the response to the middle position (M) differs significantly from the training positions P and N (Chi^2=707.785, df=4, p >0.001) , therefore only this position is considered in the further analysis.

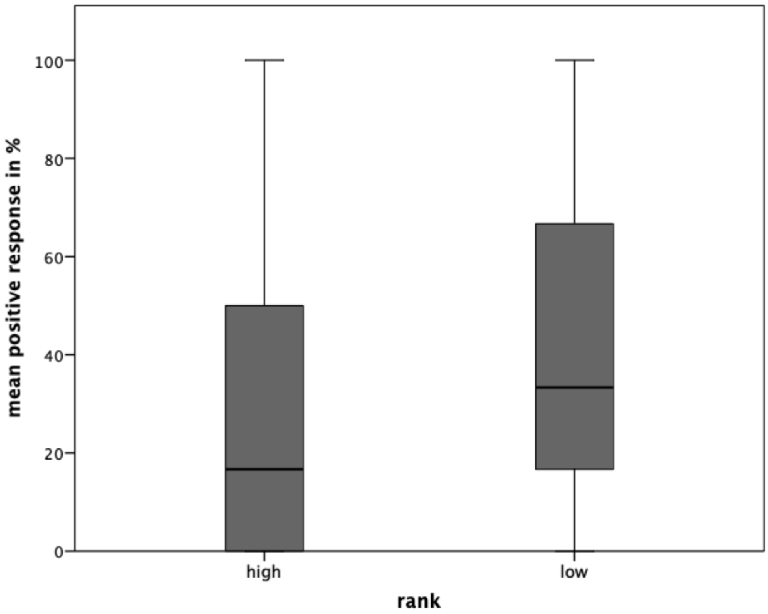

Figure 8: This figure shows the mean percentage of a positive response per individual over all three sessions, depicted on the y-axis. The x-axis is devided in high and low ranking individuals. The boxes of the boxplot indicate the interquartile range, the horizontal lines indicate (from bottom up) the minimum, the lower quartile, the median, the upper quartile and the maximin. The whiskers indicate the variability outside the quartiles.

3.3.3 Comparison of groups

Overall the full-null model comparison revealed a trend for rank and centrality influencing the probability of a positive response to the middle position (Full-Null model comparison: Chi^2=7.842, df=4, p=0.098). For rank, it showed a slight trend for low ranking individuals being more optimistic than high ranking individuals (Fig. 8). For social centrality we can see a trend for central individuals having a higher percentage of positive responses (Fig. 9). Also, sex showed to have a significant influence on the probability for a positive response with females having a significantly higher probability for a positive response (Fig. 10).

3.3.4 Interaction of sex and position in the social structure

The two separate models revealed an interaction between rank and sex (chi^2=5.120, df=1, p=0.024) whereby for females the probability of a positive response slightly increased with their rank, but for males this probability steeply decreased with increasing rank (Fig. 11). Females had rank indices ranging from 2 (being the

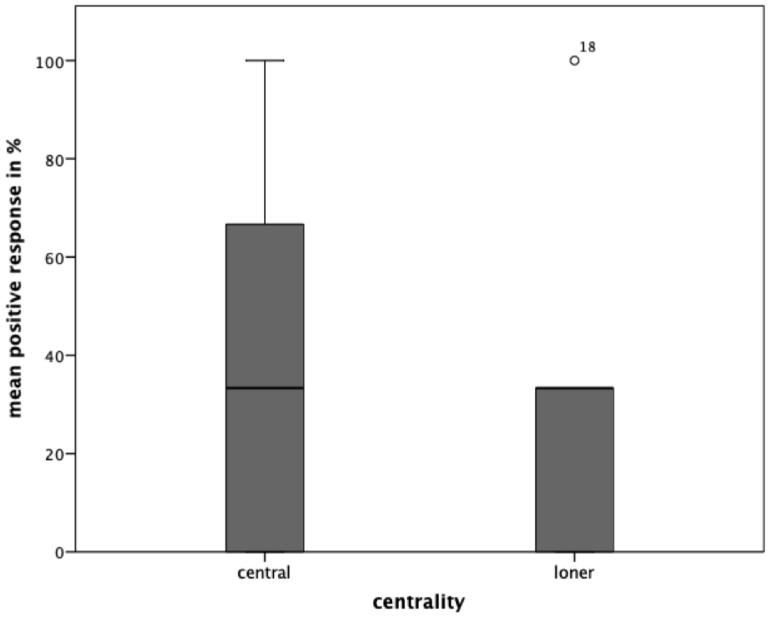

Figure 9: This figure shows the mean percentage of a positive response per individual over all three sessions, depicted on the y-axis. The x-axis is devided in centrals and loners. The boxes of the boxplot indicate the interquartile range, the horizontal lines indicate (from bottom up) the minimum, the lower quartile, the median, the upper quartile and the maximin. The whiskers indicate the variability outside the quartiles.

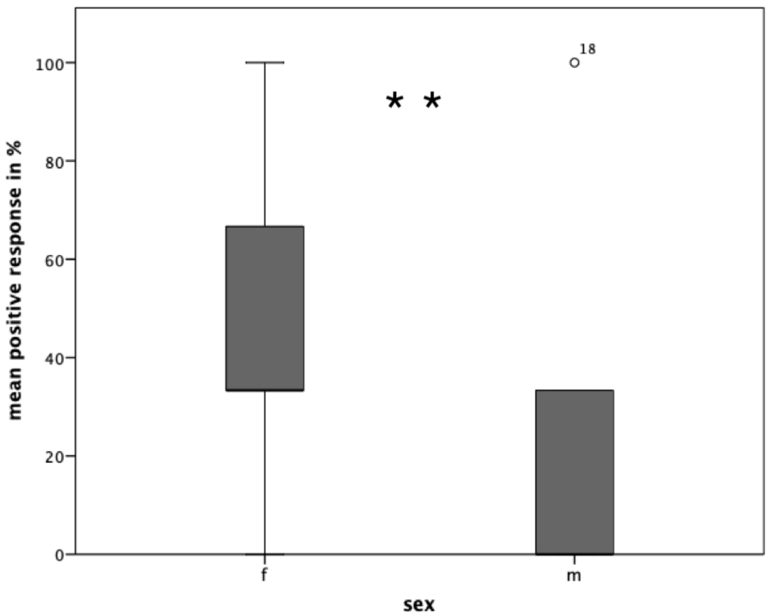

Figure 10: This figure shows the mean percentage of a positive response per individual over all three sessions, depicted on the y-axis. The x-axis is devided in males (m) and females (f). The boxes of the boxplot indicate the interquartile range, the horizontal lines indicate (from bottom up) the minimum, the lower quartile, the median, the upper quartile and the maximin. The whiskers indicate the variability outside the quartiles.

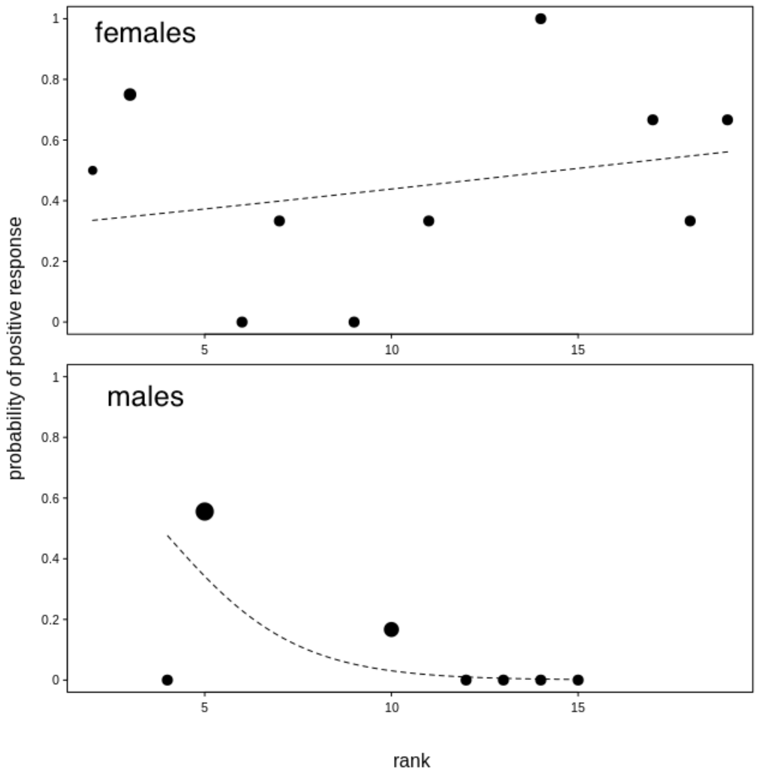

Figure 11: This figure shows the probability of a positive response on the y-axis and the rank index of the respective individual on the x-axis. The gaph on top shows the female subjects and the graph on the bottom shows the same for the male subjects. The dashed line indicates the fitted model (Chi^2=5.120, df=1, p=0.024)

lowest) up to 19 (being the highest) (mean=9.65, SD=5.76). The probability for a positive response shows higher variation than in the males, meaning that also low ranking idividuals have a high probability of a positive response. However, there is still a trend for high ranking females having a higher probability of a positive response. In males we can see a clear decrease for the probability of a postive response with a higher rank. Here rank indices range from 4 (being the lowest) to 15 (being the highest) (mean=9.16, SD=5.38). In general males have a lower probability of a positive response, which decreases with a higher rank. All the high ranking males have a probability of 0% for showing a positive response towards the ambiguous stimulus.

Furthermore, we also found an interaction between centrality and sex (chi^2= 5.618, df=1, P=0.018). Also here, the probability of a positive response clearly increased with higher centrality index values in females and clearly decreased

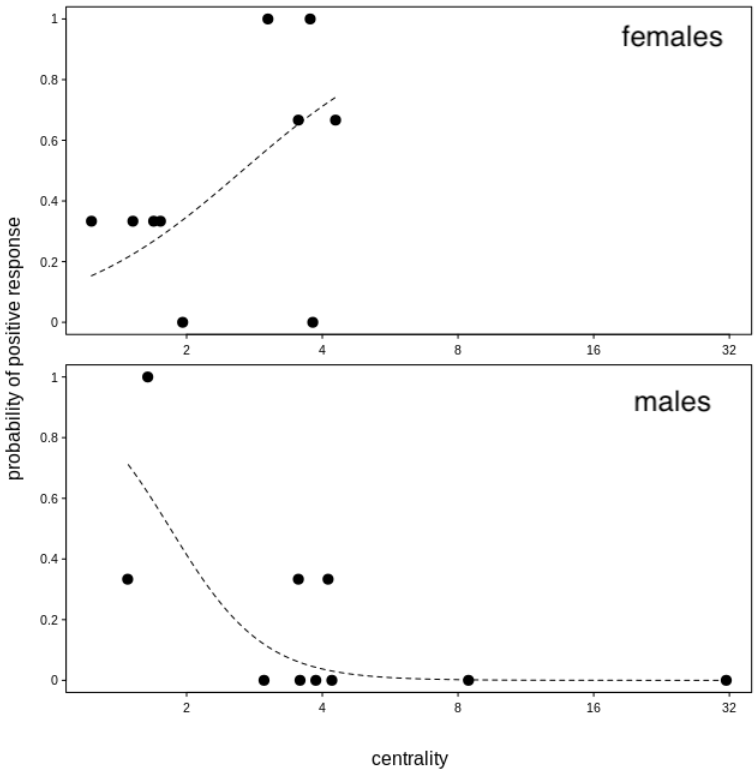

Figure 12: This figure shows the probability of a positive response on the y-axis and the centrality index of the individual on the x-axis. The gaph on top shows the female subjects and the graph on the bottom shows the same for the male subjects. The dashed line indicates the fitted model (chi^2= 5.618, df=1, P=0.018).

with higher centrality index values in males (Fig. 12). In females the value for the centrality index ranges from 1.75 until 4.28. In females the difference between loners and centrals is not as high as in males. However, it is clearly shown that the central females have a significantly higher probability of a positive response than the loner females. In males, values for the centrality index have a bigger span and range from 1.48 to 31.49. Here we can see a steep decrease for the probability of a positive response with higher centrality indices, meaning that central males have a significantly lower probability of a positive response than loner males.

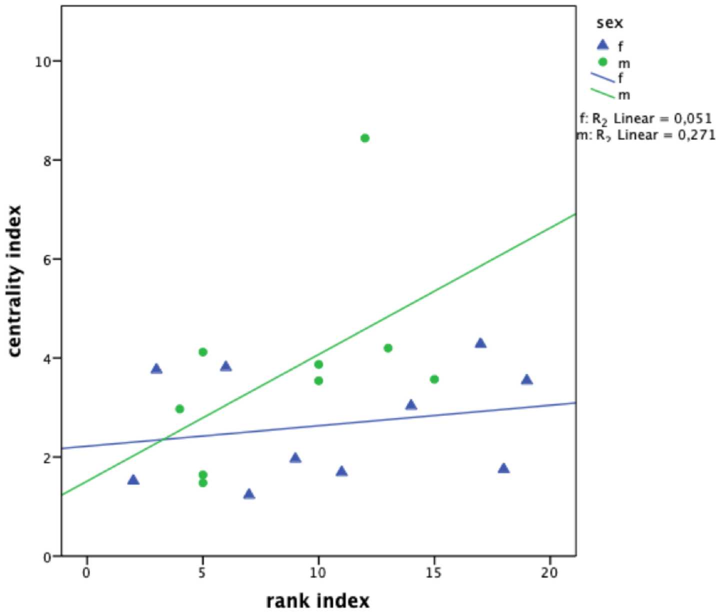

Figure 13: This figure shows the correlation of rank and centrality for males and females seperately. The blue triangles indicate female individuals and the green dots indicate male individuals. Respectively the blue line shows the correlation for females and the green line the correlation for males. In both sexes we can see a slight correlation between rank index and centrality index (pearson correlation, p=0.156).

3.3.5 Further descriptive statistics on the position in the social structure

Since the results for rank and centrality regarding the probability of a positive response are very similar (high ranking and central males show a decrease and high ranking and central females show an increase), the question rises whether there is a correlation between rank and centrality. For males and females, we can see a trend for central pigs being also higher in rank (Fig. 13). In males the correlation seems to be stronger (pearson correlation, p=0.156). than for females (pearson correlation, p=0.532). Meaning the higher ranking individuals are also the more central ones of the herd. However, both of these correlations are not very strong and therefore not significant.

Because the two centrality indices from the affiliative and the agonistic network were added to receive an overall centrality index for this study, the percentage of negative and positive interactions within the centrality index differs for each individual. In order to be able to better explain the results we correlated the overall

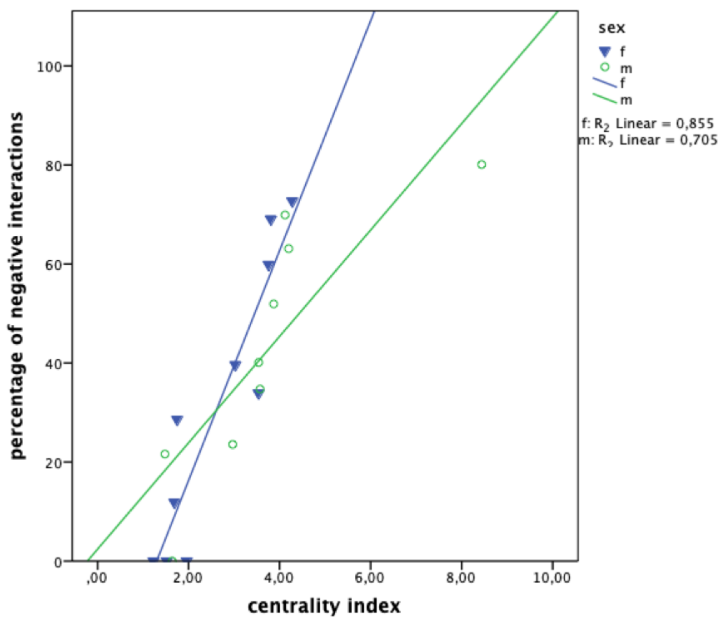

Figure 14: This figure shows the correlation of the percentage of centrality of the agonistic network and the centrality index used for males and females seperately. The blue triangles indicate female individuals and the green dots indicate male individuals. Respectively the blue line shows the correlation for females and the green line the correlation for males. In both sexes we can see a strong correlation (pearson correlation, p=0.005).

centrality index that was used for this study with the percentage of centrality that comes from the agonistic network (Fig. 14). In both sexes we can see a strong correlation of the value for the centrality index and the respective percentage of centrality from the agonistic network. Meaning the higher the overall centrality index the higher is also the percentage that makes up agonistic interactions. For females this correlation is even stronger (pearson correlation, $p > 0.001$) than for males (pearson correlation, p=0.005).

4 Discussion

The aim of this study was to investigate whether social status influences the decision making in a cognitive bias task in Kune Kune pigs. More specifically it was tested whether rank and social centrality have an influence on judging an ambiguous stimulus in a spatial discrimination task. For that reason, 20 subjects were trained to expect reward if a food bowl was placed on one side of the test arena and no reward if the food bowl was placed on another side of the arena. During testing the subjects were introduced to three novel spatially ambiguous stimuli and it was analyzed whether their response resembled more the positive or more the negative response from the training phase. This study shows that both social centrality and rank influence the response towards an ambiguous stimulus. However, the sexes have to be analyzed separately, since the response is influenced in opposite ways in males and in females. It was shown, that high ranking and central females tend to judge an ambiguous stimulus more positively than low ranking and loner females. For males we could find the opposite effect. Here low ranking and loner males show a more positively biased response towards an ambiguous stimulus than high ranking and central males (Fig. 11,12,).

Hence, females behave accordingly to the hypothesis that central and high ranking individuals judge an ambiguous stimulus more positively than low ranking and loner individuals. In males however, these factors influence the response in an opposite way. High ranking and central individuals were the ones that judged the ambiguous stimulus less positively than low ranking and loner individuals. Overall females judged the ambiguous stimulus more positively than males.

These results could be explained by the social organization of pig herds. Wild boars for example live in a matrilineal organization, meaning the social structure is built around female adult groups and their offspring (Kaminski et al., 2005) Males disperse in the first year and mostly live solitarily with loose interactions to the mother daughter-groups. Females stay with their mothers and even engage in facultative cooperative breeding and bonds of these center groups are known to be very tight (Mauget, 1981). Since the behaviour of domestic pigs is comparable to the one from wild boars (Stolba and Wood-Gush, 1989), this might also apply to the pig herd of this study. The Kune Kune pigs from this study are housed under semi-natural conditions. This means that although their surrounding allows them to display their natural behavior, they are still restricted in their movement by a fence around the 8ha pasture. Also, they are provided with additional food on the same feeding sites every day and since the boars are vasectomized, females do not become pregnant and are in heat once per month, which also keeps the boars close by. These factors might contribute to a slightly differing social organization of the observed herd compared to wild boar/feral pig herds. Females and especially males might in this case live closer together than their wild ancestors would.

Influence of social centrality on the judgement bias

According to the social network analysis, which was conducted before choosing the subjects for the judgement bias task, central individuals are the ones with a lot of interactions to a lot of other group members. This might be a more natural way of living for females than for males in pigs, since for example in feral pigs, females already as piglets interact with other females and form associations which persist into adulthood (Graves, 1984). The two main advantages of group living for female pigs seem to be firstly the possibility to breed cooperatively, where yearling females engage in rearing offspring (Mauget, 1981) and by that gain inclusive fitness (Hamilton, 1964). And secondly the ability to learn the family home range and by that have easier access to resources (Kaminski et al., 2005). It was also shown that piglets can learn socially from their mothers and aunts in the context of foraging (Veit et al., 2017). Usually females only split up into smaller groups when resources become insufficient and competition gets too strong (Higashi and Yamamura, 1993), which is never the case in the tested pig herd, since feeding resources are kept at a constant level. Furthermore, literature in humans and other animals such as rats and mice shows that quantity and quality of social interactions has a significant effect on overall psychological and physiological health and even on mortality rates (House et al., 1988; Cassel, 1976). More specifically, social relationships might act as a buffer for stress and general health hazards (Cassel, 1976). All of these factors might contribute to females naturally experiencing less social stress than males when living in groups since benefits seem to outweigh the costs. This might lead to the finding of this study that central females with many social interactions tend to judge ambiguous stimuli more positively than loner females (Fig. 12), since it is generally assumed that an overall better mental and physical state leads to a more positively biased judgment (Yeates and Main, 2008).

In males however, centrality influenced the judgement bias in a negative way. More central males judge am ambiguous cue less positively than loner males (Fig. 12). Also, here the natural social structure of pig herds might be a possible explanation. Boars disperse in the first year and from there live solitarily and only join the female groups during reproductive periods (Mauget, 1981). The semi-natural conditions, which the Kune Kune pigs at the research station Haidlhof are kept under, keep the males from dispersing. By the spatial restriction, competition might be kept at are higher and more constant level. From their ecology, boars are not used to sharing a relatively small area with many other boars and also constantly with females. Since females also do not become pregnant, they ovulate once per month. The constant opportunity to compete over ovulating females, might be a reason why especially central males had a very high percentage of agonistic interactions (Fig. 14). The thereby increased aggression levels might put boars under stress which might lead to less positively biased judgement. This does however not mean that the boars of this study had to engage in agonistic interactions constantly. The 8ha pasture still gives them enough space to spread out and avoid competition and agonistic encounters. This might be the reason, why loner males do have a more positively biased judgement. They have to face less competition when accessing food resources. Mating related behaviours were not analyzed in this study, but it might well be the case that more central males do have a higher mating success which compensates for the additional stress of competition. It is also often observed in the herd that central males do become loners after some time and recover. The area the pigs are kept in, gives them the opportunity to do so.

Also, this study shows that females in general have a higher probability to judge an ambiguous stimulus more positively than males (Fig. 10). Even though for both males and females the percentage of negative interactions increases with higher centrality (14), only the more central males judge ambiguous stimuli less positively. In this study a centrality index was calculated including all interactions from the affiliative social network and from the agonistic social network. The centrality index from the agonistic network consist of eight negative interactions including fights, displacements with and without body contact, threats and an individual being chased. This means that not every individual experienced the same interactions, and some might be more weighty than others. Especially in males, agonistic interactions often include severe fights, with one or both partners leaving the interaction with mild injuries. From wild boars it is known that especially the males are reputed fierce fighters, which often hurt each other with their sharp lower and upper canines (Barrette, 1986). The resulting pain can also lead to a more negative judgement bias, which was shown in a study on dairy calves. Here calves judged an ambiguous stimulus more negatively after hot-iron disbudding (Neave et al., 2013). In females, severe fights do occur but were not observed during the time of the experiments. Here agonistic interactions are more often displacements and threats and injuries are very rare. So even though central females do also have a higher percentage of negative interactions, the quality of those interactions might be different and might have less of a severe effect on their overall stress-level and wellbeing.

Nevertheless, we can only speculate on how an individual perceives a specific interaction and what impact this has on its general affective state. Negative interactions could be perceived as more weighty than positive ones. From what we know from human psychology, a so-called negativity bias does exist. Meaning that negative events are perceived as more meaningful and with a greater potency than positive events (Rozin and Royzman, 2001). For future studies I would therefore suggest analyzing agonistic and affiliative centrality separately or to look at single behaviours, how it was also done in previous studies investigating social interactions and cognitive bias (Schino et al., 2016), (Clegg et al., 2017). Creating an overall centrality index with agonistic and affiliative interactions made the results of this study harder to interpret.

Influence of rank on the judgement bias

Regarding the influence of rank on a judgement bias, this study showed that in females the higher ranking individuals judged the ambiguous stimulus more positively than lower ranking individuals. For males the results show an opposite effect, being that lower ranking males tend to have a more positive judgement bias than high ranking ones.

Hierarchies are mainly established to regulate the access to different resources (Cummins, 2005). Generally, in hierarchies both positions (high and low ranking) come with benefits and costs, which are dependent on the social organization of the animal group (Sapolsky, 2005). In most animal groups however, being high ranking seems to be more beneficial regarding access to mating partners, food sources and resting places (Cowlishaw and Dunbar, 1991), (Ingólfsdóttir and Sigurjónsdóttir, 2008). However, there are also studies that show that being high in rank comes with high cost, especially in terms of physiological stress level. Especially in species with non-stable dominance hierarchies, such as wild dogs and ring-tailed lemurs, high ranking individuals are the ones with overall higher stress levels (Sapolsky, 2005).

The matrilineal social organization of pigs also includes hierarchical structures. In female groups with mother and offspring, sows are dominant to all other group members and also juveniles maintain a relatively strict hierarchy. When a boar joins the group for reproduction, it takes over the dominant position over all females (Gonyou, 2001). This suggests that females live in a more stable hierarchy according to their age which makes it less necessary to compete for the higher positions. Less competition goes along with less physiological stress for high ranking pigs while still benefiting from the high ranking positions with better access to food resources and resting places. That might be the reason why high ranking females tend to have a more positively biased judgement than females of a lower rank in our task. They might be more used to gaining access to resources without having to encounter high costs for it.

Contrarily in males the high ranking individuals were the ones which judged the ambiguous stimulus less positively. Here the stress of being on top of the hierarchy might interfere with a positive judgement bias. A study by Gesquiere et al. (2011) for example revealed, that in wild male baboons the highest ranking individuals were the ones with the highest concentration of glucocorticoid-levels, which is a stress hormone. Additionally, it has been found that higher stress related glucocorticoid-levels lead to a decrease in positively biased judgement in rats (Enkel et al., 2010). While female hierarchies seem to be more stable and linear according to age, male hierarchies are much more instable and also not part of the boars natural ecology since they live mostly solitarily. Hence especially the males might have to engage in more agonistic interactions in order to ensure the high rank and access to resources such as mating partners. As already discussed above ovulating females might be a limiting factor for the boars of the observed herd and act as an additional stressor for the males. A study on African mice for example found that reproductive competition favors solitary living, whereas environmental constraints favor group living (Schradin et al., 2010). For males, the reproductive competition might act as an additional stressor by increasing aggression. This was also shown in a study on captive European wild boars, where the highest rates of aggressive encounters were observed for limited and defendable resources (Schnebel and Griswold, 1983). Regarding the cognitive bias test, it is known that more negative stress leads to more negatively biased judgement (Pomerantz et al., 2012). A higher stress-level in high ranking males might therefore be an explanation for a less positively biased judgement of ambiguous stimuli. Contrarily, the low ranking males judged the ambiguous stimulus more positively. This might be because they engage in less aggressive and stress inducing behaviour while still having access to plenty of food resources. A study in vervet monkeys for example found that low ranking individuals spend the same amount of time feeding than high ranking ones but engage in less scanning behaviour for predators (Isbell and Young, 1993).

Constraints of cognitive bias tests

Even though the cognitive bias task has become a well-established method for studying the valence of animal emotions, results should still be interpreted with care. Some scientists go as far as to classify individuals as optimistic or pessimistic depending on their response being positively or negatively biased towards a novel ambiguous stimulus (Matheson et al., 2008),(Bateson et al., 2011),(Douglas et al., 2012). It is however not to be assumed that affective states are perceived in the same way as the human equivalent of being optimistic or pessimistic. Animal emotions are as complex as the ones from us humans with the additional doubt whether they are experienced consciously (Mendl et al., 2010). That is why, the term "Cognitive bias test" should be seen as an umbrella term for various tests studying the effect of affective state on components of animal cognition such as attention, memory and judgement (Mendl et al., 2009). The spatial discrimination judgement bias task used in this study, tested whether an individuals response was more positively or more negatively biased towards a novel and ambiguous spatial stimulus after being trained to distinguish between a spatial stimulus with a positive outcome and one with a negative outcome. How much this tells us about the overall affective state of an individual is however not clear. In order to get a more complete picture about affective states, it would be necessary to conduct more cognitive bias tests over a longer period of time and investigate whether these states change over time. Ideally for this study, it would be interesting to test an individual before and after a change of position in the social structure and how this change affects the response in such a test. A time restricted difficulty for this study was that the social network analysis and the hierarchy tests were conducted in the months before the cognitive bias test and not during the same time span. Hence, small changes in rank and social centrality might have occurred in between the data collection for the social structure and the actual judgement bias test. Nevertheless, the choice of subjects for the test was made carefully, not to choose an individual that was instable in its position at that moment, so big changes in the social position of the subjects are unlikely.

Another difficulty to face when conducting judgement bias tests, is the learning effect towards the ambiguous stimuli. We tried to solve this problem by a very low number of ambiguous trials in between reinforcement trials in the test sessions, however a learning effect could still be observed. Since the ambiguous stimuli were never rewarded a decrease in positive responses towards them over the three sessions could be seen. The same effect could be seen in a study on sheep, where the subjects were also trained in a spatial discrimination judgement bias task. Also, in this study the ambiguous stimuli were negatively reinforced, meaning not rewarded and a significant decline of positive responses over the three test weeks could be observed (Doyle et al., 2010b). To validate the results of this study, it would also here be important to conduct different kinds of judgement bias tasks with novel ambiguous stimuli, for example a colour discrimination task or an auditory discrimination task and test whether individuals respond in the same way as in the spatial task. Since the first design of a judgement bias task in by Harding et al. (2004) numerous variations have been conducted with differing cues, expected responses and species (Mendl et al., 2009). Each experimental design comes with advantages and disadvantages for the differing physiology and ecology of the study species. A point of critique for the spatial task used in this study, could be that pigs are known to have poor eye sight (Hutson et al., 2000), (Lomas et al., 1998). The food bowls used as a cue were placed in a half circle 3.70m from the viewpoint of the subjects and we cannot make a clear statement on how well the pigs are able to see the bowl at that distance, since it is suggested that pigs only use their vision for cues that are directly in front of them (Koba and Tanida, 2001). However, it is also known that their visual angle is between 310 and 250° (Prince, 1977), (Tanida et al., 1996), which gives them the ability to have a good overview of their surroundings (Adamczyk et al., 2015) and therefore probably also a good overview over the test arena from the waiting compartment. From the training sessions and videos, it could be seen that pigs approach the food bowl almost directly from the moment the door to the test arena was opened, even in the first sessions when they were not trained yet, which suggests that they are indeed able to see the food bowl well enough for this test to be valid. For further judgement bias tests on this species it might still be an improvement in the methodology to conduct a test with stimuli that are closer to the subject, for example on a touch screen. This seems like a suitable method since it has been shown by Wondrak et al. (2018) that pigs have the ability to visually process information and work on a touchscreen.

Conclusion Up to date there are not many studies investigating social effects on cognitive biases, especially not in farm animals. Here the focus lies mainly on housing conditions and stress-inducing procedures. With the pig herd of the Messerli Research Station we had the unique possibility to investigate whether different judgement biases also occur under semi-natural conditions and how they are influenced by the social status of the individual. The spatial discrimination judgement task that was used appeared to be a suitable methodology for this aim but should be validated in the future by modified cognitive bias tasks in further studies. With this study a further step was made to understand more about the social cognition of pigs. It was shown, that there are huge individual differences in the judgement of an ambiguous spatial stimulus within the pig herd. For the pigs of this study, these differences are influenced by the social status of the individual and the sex. While in females the more socially central and high ranking individuals showed a more positively biased judgement towards an ambiguous stimulus, in males the opposite was the case. More socially central and high ranking males showed a less positively biased judgement. A possible explanation for these results might be the social organization of wild and feral pigs, which is comparable to domesticated pigs. As from their ecology, for females it might be more natural and beneficial to live in groups and within the group be of a higher rank. For males however group-living is not part of their natural ecology and might put them under higher stress levels. Since these results are based on a single study with one herd of Kune Kune pigs, it would be important to validate these findings by conducting further cognitive bias tests on various pig herds, ideally including feral pigs and wild boars.

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6 Appendix

Abstract

From human psychology it is known that emotions affect cognitive processes such as memory, attention and judgement and it seems that the same also applies for animals. Since in recent years, animal welfare research not only focuses on the physical well-being of animals, but also takes into account their emotional well-being, tests have been implemented to investigate emotional states in animals. The cognitive bias test has proven to be a valuable method to assess the valence (positive or negative) of an affective state in various animal species. Especially in farm-animals judgement bias tests are a useful tool to assess whether an individual is in a positive or negative affective state. Most studies in this field of research focus on effects of different housing conditions or the effect of stressful procedures such as sheering in sheep. For common farm animals there are however no studies up to date investigating whether also social factors have an effect on an individuals affective state. Hence the aim of this study was to investigate how an individuals position in the social structure affects decision making in a judgement bias task of a common farm animal, the domestic pig. From a herd of 39 free-ranging Kune Kune pigs, subjects were chosen based on their social rank and on a social network analysis focusing on central and loner pigs. Subsequently, 20 individuals were trained in a spatial discrimination task, where they had to learn to distinguish between a positive (rewarded) and a negative (unrewarded) spatial stimulus (a food bowl which was placed on either the left or the right side of the test arena). After reaching a pre-set training criterion, the subjects were tested in a judgement bias task by introducing three novel spatially ambiguous stimuli in between the two positions from the training and go/no-go responses towards these novel stimuli were analyzed. It was shown that there is a significant effect of social centrality and rank in interaction with sex on the judgement of spatially ambiguous stimuli. In this study, high ranking and central females judged the ambiguous stimulus more positively than low ranking and loner females. For males we found the opposite effect; here low ranking and loner males

were the ones judging the ambiguous stimulus more positively than high ranking and central males.

Zusammenfassung

Aus Studien in der Humanpsychologie ist bekannt, dass kognitive Prozesse wie Aufmerksamkeit, Gedächtnis und Urteilsvermögen von Emotionen beeinflusst werden, dies ist mit hoher Wahrscheinlichkeit auch bei Tieren der Fall. In den letzten Jahren fokussiert sich die Wissenschaft des Tierwohls nicht nur auf die physische Unversehrtheit von Tieren, sondern legt außerdem Wert auf deren emotionales Wohlsein. Aus diesem Grund führte man Versuche ein, mit denen es möglich ist Emotionen und Gemütslagen bei Tieren zu untersuchen. Mit sogenannten kognitiven Verzerrungstests war es bereits in vielen Spezies möglich die Valenz (positiv oder negativ) einer Gemütslage zu testen. Vor allem bei Nutztieren führte man sogenannte Urteils-Verzerrungstests durch, um herauszufinden ob sie sich in einer positiven oder negativen Gemütslage befinden. In diesem Bereich der Wissenschaft geht es meist darum herauszufinden welchen Effekt unterschiedliche Haltungsbedingungen oder übliche Prozeduren so wie das Scheren bei Schafen auf die Tiere haben. Bis jetzt gibt es jedoch noch keine Studie darüber ob auch soziale Faktoren den Gemützustand von Nutztieren beeinflussen können. Das Ziel dieser Studie ist daher zu untersuchen wie sich die Position eines Individuums in der sozialen Struktur einer Herde auf die Beurteilung eines neuen potenziell mehrdeutigen Stimulus auswirkt. Durchgeführt wurde diese Studie an einem üblichen Nutztier, dem Hausschwein. Aus einer Herde bestehend aus 39 Kune Kune Schweinen wurden die Versuchstiere aufgrund ihres sozialen Ranges und aufgrund einer sozialen Netzwerk Analyse, die sich auf zentrale und dezentrale Individuen fokussierte, ausgewählt. Anschlieend, wurden 20 Versuchstiere trainiert zwischen einem positiven (belohnten) und einem negativen (unbelohnten) räumlichen Stimulus zu unterscheiden (der Stimulus war eine Futterschüssel, die entweder auf der linken oder der rechten Seite der Test Arena positioniert wurde). Nachdem die Tiere ein vorab bestimmtes Trainingskriterium erreicht haben, wurde ihre Voreingenommenheit in der Beurteilung eines neuen potentiell

mehrdeutigen Stimulus getestet. Dies geschah indem die Futterschüssel jeweils auf eine von drei neuen Positionen zwischen den ursprünglichen Trainingspositionen platziert wurde. Diese Positionen konnten von den Versuchstieren mehrdeutig interpretiert werden und es wurde für jedes Tier aufgenommen ob es sich der neuen Position annähert oder nicht. Es konnte gezeigt werden, dass der soziale Rang und die Zentralität im sozialen Netz in der Interaktion mit dem Geschlecht des Individuums, einen signifikanten Einfluss auf die Beurteilung eines neuen, mehrdeutigen Stimulus haben. Die hochrangingen und zentralen Weibchen dieser Studie, beurteilten einen neuen Stimulus positiver als die niederrangingen und dezentralen Weibchen der Herde. Bei den Mänchen war ein gegenteiliger Effekt zu beobachten. Hier beurteilen die niederrangingen und dezentralen Individuen den mehrdeutigen Stimulus positiver als die hochrangigen und zentralen.