# Behaviour Genetics of Pigs

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## Summary

The behavior of pigs can be divided into several categories, which include maternal behavior, aggressive behavior, sexual behavior, feeding behavior, and various other forms of emotional behavior. Domestication has caused many changes in the original behaviour of boar, such as in reproductive and sexual behaviour, and has lead to a general increase in social tolerance between animals. Further modifications in behaviour are also possible, as suggested by the optimization of environmental factors which affect maternal behavior. The behaviour of a sow after farrowing appeared as a consequence of natural selection for protection of piglets from predators in the wild boar population, and affects the survival of piglets and the longevity of the sow in breeding. The behavior of the sows which includes the protection of the piglets from predators appears as a consequence of natural selection in the wild boar population. Familiarity with the molecular mechanisms which determine the patterns of behavior enables understanding of behavioral problems such as aggressiveness and helps the improvement of the well-being of pigs. Research conducted on pigs has determined that there are regions on chromosomes 2, 6, 10, 14, and 15, and chromosome X which can explain the genetic aspect of appearance of some behavioral patterns in sows. The goal of this paper is to illustrate the behavioral patterns appeared in the populations of domestic breeds of pigs and their genetic aspects, which knowledge may provide some help in improving the production qualities and creating higher economic gain during production.

## Key words

pig, behaviour, farrowing, behavioural patterns

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## Introduction

Behaviour patterns which are expressed in pigs are under genetic control. Pigs can express maternal, aggressive and sexual behaviour but also patterns of behaviour that occur during eating and drinking. The most aggressive form of maternal behaviour that occurs in sows is cannibalism (Rothschild and Ruvinsky, 2011). Aggressive behaviour is in direct relationship with the reduction of the welfare of pigs, and thus with a success in all phases of pigs production (Løvendahl et al., 2005). Genetic aspects of behaviour during feeding pigs have been confirmed by a large number of scientists in their research.

## Maternal behaviours

The number of live piglets and the number of piglets per farrow are factors which should be carefully controlled in breeding programs. If the selection is performed to increase the number of piglets per farrow, it will not necessarily directly affect the number of weaned piglets. That depends on the sow and on its ability to take care of the piglets in the farrow (Rothschild and Ruvinsky, 2011). Maternal ability of a sow can be measured by the reaction that sow has when it is separated from the piglets or when piglets are crushed by its body mass (Gäde et al., 2008). The factors which affect the behavior of the sow include the type of the floor in the area which the sows is reared, the flooring of the litter, the breeding system of the sow. Open breeding systems provide the sows an access to open areas that allow the sow to more freely move and reduce the amount of care for piglets as respect to to the closed breeding system (Blomberg, 2010). Variability in behaviour may be related to hormonal status of the sow (Rothschild and Ruvinsky, 2011). The improvement of maternal behavior would have the goal of increasing the survival rate for piglets until weaning. An increment of sow maternal attitude may also improve animals well-being, and provide a greater economic income for farmers. Gäde et al. (2008) observed that maternal behavior also depends on the breed of the pig. Sows of the Yorkshire display better maternal behavior than sows of the Landrace, while the sows of the Duroc are more aggressive than sows of the Landrace (Gäde et al., 2008). Crossbreeds have shown inferior maternal instinct when compared to purebreds, but research has confirmed that no large significant differences between purebreds and crossbreeds exist (Rothschild and Ruvinsky, 2011). Research was conducted to find out the moment of pig domestication in which the change in maternal behavior appeared. Results of the research revealed behavioural differences between crossbreeds of domestic pigs and crossbreeds of domestic pigs and wild boars. These differences were related to the length of time in which the sow takes care of the piglets and the frequency in standing up and laying down during the night to change position (Rothschild and Ruvinsky, 2011). The sow displays different patterns of behavior toward the piglets. The most aggressive form of behavior is cannibalism, consisting in biting, killing, and finally eating its own piglets. Three forms of cannibalism can appear. The first one is due to an hyperactivity of the sows after farrowing. The second form is a consequence of the rejection of the piglets by the sow and of the aggressiveness toward the piglets trying to approach it. The third form is connected to the aggressive state of the sow which appears after farrowing and it is similar to to the mental disorder which can appear in women after childbirth. This form of cannibalism and aggressiveness may cause in the death of the entire litter (Rothschild and Ruvinsky, 2011). Negative sow behaviours toward piglets are mainly connected to the hypersensitivity of sows during their first parity, but it is also possible they appear in later stages of life. Once they appear, it is likely they will not stop and they would result in the loss of the entire litter. Longevity and successfulness of a sow to raise its piglets is dependent on the heritability for maternal behavior during the lactation period. Maternal behaviour during the lactation period affects the successfulness of a sow to raise its piglets. Heritability values for maternal behavior have been estimated in a number of studies. Vangen et al. (2005) attained heritabilities from 0.0 for the neglect of piglets, 0.12 for the reaction to the sounds the piglets made, and 0.17 for the fear that appeared during the handling of piglets. Grandinson et al. (2003) made a genetic estimation of four traits which can affect the survivability of piglets. The properties included the reaction of the sow to the sounds the piglets made and to the handling of piglets, and the reactions of aggressiveness and fear toward people who are conducting piglet handling procedures. The estimated heritability values were 0.06 for the sounds the piglets made, 0.01 to for the reaction handling, and 0.08 for fear and aggression. Gäde et al. (2008) made an estimate for the heritability value of various categories of behavior. Heritability for group behavior (social behavior) was 0.07, for maternal behavior 0.05, and for behavior toward people 0.06. Crushing of piglets by the sow is a property with a low heritability value of 0.03. Low heritability values for maternal behavior indicate that the genetic improvement of this trait is difficult. Heritability values in the research conducted by Grandinson et al. (2003) ranged from 0.01 to 0.08. Traits under study were the aggression of the sow toward people, reaction of the sow to the sounds the piglets made, and the reaction of the sow to the people handling the piglets. In their research, Chen et al. (2009) showed that the percentage of killing their own piglets has reduced from 12.8% in the first farrow to 7.5% during the second and 4.5% in the third farrow. Rothschild and Ruvinsky (2011) said that piglet mortality is caused by the carelessness of the sow in 30% of the cases and by inappropriate feeding of the piglets in 70% of the cases. Seven regions of chromosomes connected to this form of behaviour in sows were detected. The regions were on chromosome X and chromosomes 2, 6, 14 and 15. Quilter et al. (2007) conducted their research to analyze the QTL connected with the occurrence of abnormal behavior in sows and killing their own piglets. The discovered QTL were on chromosome X and on chromosomes 2 and 10. The behavior of sows during the lactation period is extremely important for the survivability of piglets, because the piglets are dependent on their mother's milk in their first days (Quilter et al., 2007). Although selection for increasing the number of piglets per farrow and after weaning was successful, there were no significant advances in improving the survivability of piglets. The 45% of piglet deaths is a consequence of crushing by their mother (Nora et al., 2009), while only 20% is the consequence of feeding errors. All the differences that appeared can be explained by three factors, those are the calmness of the sow, the protection of the piglets by the sow, and the care for the piglets.

## Aggressive behaviours

Aggressive behavior of piglets and pigs appears when mixing piglets from different farrows, or in condition of insufficient feeding which causes competition for food (Fraser and Rushen, 1987). The consequences of aggression are injuries which reduce the well-being of animals, but also their longevity in the farrow. In order to reduce the negative effects of aggression, it is important to determine their genetic variation. Løvendahl et al. (2005) said that so far there were no studies connecting the properties of the maternal instinct, the appearance of aggression and the productive traits of pigs. Reduction of aggressiveness is an important goal in pig production, that can lead to the increase in well-being, improvement of health and productivity. Bergsma et al. (2008) conducted research on a sample of 14.032 pigs with known pedigrees. The research was used to estimate the incidence of direct and social genetic variance (Bijma, 2013) on the properties of thickness of back bacon, food intake, and thickness of muscles. The total heritable variance (Bergsma et al., 2008) in relation to phenotypic variance was 71% for the growth rate and 70% for food intake. Thickness of back bacon and thickness of muscles displayed no hereditary variance connected to social effects. In their research Turner et al. (2006) intended to establish a lesion score in pigs in relation to the appearance of lesions on the skin. The estimated heritability value for the lesion score was 0.22. Research conducted by Turner et al. (2008) was aimed at determining the lesion score over time, considering the period the pigs spent together. The lesion score was noted 24h after the pigs were mixed, while in previous research the lesions on the skin appeared in the period of 3 weeks after the mixing of piglets from different farrows.

## Sexual behaviours

There are several categories of sexual behavior; those are the courtship of male and female, estrus expression, and the behaviour expressed at the moment of reproduction. The stated categories can be partially or completely controlled by genes (Johnson and McGlone, 2011). Goy and Jakew (1969) have explained the genetic basis for sexual behaviour of animals for the first time, but their research was not aimed at studying such behaviour in pigs. One of the most important properties connected with the production of gametes is individual libido, that shows a high genetic variability. Several researchers have investigated the genetic basis for sexual behavior in pigs. Flowers (2008) aimed his study at reviewing phenotypic and genetic variances of reproductive traits in boars included in artificial insemination program. The conducted study has shown that crossbred boars have a higher libido than purebred boars. There are breeds of pigs, as the Chinese Meishan, where females display the first signs of estrus very early in life (Wilson et al., 1977). The appearance of estrus after weaning of piglets is a property which is influenced by genes and it can be used as a tool for identification of major genes which participate in its expression. Flowers (2008) also mentioned in his study that in most commercial boars evaluation of mating behavior only consists in measurement of the proportion of boars that could not be trained for collecting semen collection. An average percentage of 15±4 unsuccessfully trainings was measured, and no statistically significant differences were found between genetic lines (Flowers, 2008).

## Feeding and drinking behaviours

Pigs display different feeding behaviors depending on their age and the stage of production. Pigs after weaning do not consume larger quantities of dry food. Rothschild and Ruvinsky (2011) reported heritability values of feeding behavior from the research conducted by Atkins (1989). Piglets were weaned at the age of 28 days and the observed feeding behavior included the number of feeding bouts, the duration of feeding and the time period from weaning to the first consumption of food. Heritability values were very high and their value was $h^2$=0.87. Later research involving the influence of QTL on the feeding behavior was done by Houston et al. (2005), Reiner et al. (2009), and Zhang et al. (2009). Reiner et al. (2009) determined that there are eight QTL connected with the behavior of pigs during feeding. Combined effects of SSC5, SSC18, and SSC7 explained 40% of the phenotypic variance. Feeding and the consumption of water are connected, so these two events should not be observed separately. QTL which affect water consumption were also determined, those are SSC5, SSC7, SSC11, SSC12, SSC15, and SSC16. Research conducted by Zhang et al. (2009) detected eight QTL for traits related to feed consumption and feeding behaviour, as the feed conversion ratio and the number of visits to the feeder per day. QTL influencing food conversion were found on SSC2, SSC7, SSC8 and SSC9, whereas SSC3 resulted as affecting the average quantity of consumed food during the day. The effect of the other discovered QTL could be seen in the growth and properties of carcass and the storage of fat, which confirms the pleiotropic influence of genes on the stated properties. Several genes affecting the consumption of food and the growth of pigs were found, those are melanocortin-4 receptor, insulin like growth factor 2, cholecystokinin receptor type 2 (Zhang et al., 2009), leptin and leptin receptor (Houston et al., 2005). An important QTL which affects the consumption of food was detected near the gene mutation of the insulin like growth factor 2, which influence is reflected in the property of carcass quality (Houston et al., 2005). The conducted analyses included the breeds of pigs Pietrain, Meishan, Duroc and their crossbreds. The analysis has determined a QTL which affects the daily quantity of consumed food in the fattening period from 55 kg to 80 kg. The stated QTL has been determined on SSC2 at 28cM. The existence of a QTL for the average daily gain was determined on chromosomes 8, 11, and 17, for the daily intake of food on the chromosomes 11, 13, and 17, for food conversion on chromosomes 11, 12 and 14, for time spent feeding on chromosome 6. There was research on the feeding behavior of pigs that were housed in a group (Hear, 1992; von Felde et al., 1996; Hall et al., 1999; in: Rothschild and Ruvinsky, 2011). The authors observed the various factors affecting group behaviour, such as the quantity of consumed food during the day and the behavioural patterns exhibited during food intake. Heritability values for food intake were from 0.16 to 0.30 for von Felde et al. (1996) and 0.18 to 0.26 in the research conducted by Hall et al. (1999).

## Conclusions

Behavioral patterns are a basic element for the functioning of each organism, but they are also an important part of production in pig farming. By recognizing their occurrence and applying selection procedures it is possible to use the desirable patterns

in the production process, therefore helping the advancement of production. The genetic aspect of various behavioural patterns, that can be grouped in categories as maternal behaviours, aggressive behaviours, sexual behaviours and feeding and drinking behaviours have been shown. Furthermore, the paper reasoned about the relations between behaviours and the possibility of their application in the production process.

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