Breeding pigs for good behaviour

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Highlights

- Most pigs in commercial production are kept in a barren environment which increases the risk of damaging behaviours such as tail biting
- Tail biting and aggressive behaviour are heritable traits and selection works, but these behavioural traits are complicated to record in a large scale
- The social model, resulting in direct and social breeding values for growth rate, enables selection for 'good behaviour' without recording behavioural traits
- New technology and methods, such as sensors and image analysis, can facilitate recording of social and damaging behaviours
- More studies in behavioural genetics are always wanted, but there is already available knowledge that can be implemented by breeding companies striving for improved animal welfare

What kind of animal is the pig?

It seems like George Orwell, author of the classic Animal farm, knew pigs' cognitive capacity as he wrote: 'The work of teaching and organizing fell naturally upon the pigs, who were generally recognized as being the cleverest of animals' (Orwell, 1945). Pigs are group-living social beings with large cognitive abilities.

Pigs are generalists and omnivores which means they can eat almost everything and adapt to many different environments, and they spend a large part of the day exploring and foraging. A successful omnivore living in the wild where food availability varies over time need to be highly explorative. Domestic pigs living in semi-natural conditions spend up to half their waking time searching for food, rooting and chewing *(Stolba and Wood-Gush, 1989)*. There is not much to explore in the environment we provide pigs used in commercial production. Pigs are kept in static, barren pens where they are fed only twice per day and eating is over in a few minutes. In such a boring environment pen mates are the only 'thing' worth exploring – pen mates at least move and change when explored *(Figure 1)*.

Social and damaging behaviours of pigs

Wild boars and feral pigs live in stable groups and thus avoid aggression. In contrast, most pig production systems involve repeated mixing of unacquainted pigs. When pigs that do not know each other meet they fight to establish a social rank order. After mixing, most pigs are involved in fights which costs energy and causes skin lesions and other injuries. Pigs can identify unfamiliar individuals in groups as large as 80 pigs *(Turner et al., 2001)*. Also pigs in stable groups perform some aggressive behaviour (but much less than after mixing) to maintain dominance and control access to food *(Fraser, 1984)*. Playing, resting and eating together at the same time (being gregarious) and nosing, nibbling, sucking and chewing on pen mates are other examples of social behaviours in stable pig groups.

Aggressive behaviour

Pigs show stable individual differences over time in performance of aggressive behaviours such as bullying, threatening, biting, violent pushing and chasing. Heritability estimates for aggressive behaviour at mixing range from 0 to 0.5 (see for example *Løvendahl et al., 2005, Turner et al., 2006, 2009, Hellbrügge et al., 2008, Stukenborg et al., 2012, Appel et al., 2016, Scheffler et al., 2016*). In general, the heritability for performing aggressive behaviour seems to be higher than the heritability for being a receiver. It is, however, much easier to identify the receivers; it can be done by counting skin lesions. Lesions in the front indicate that the pig is an attacker and lesions in the back of the body indicate that the pig is a receiver *(Turner et al., 2009)*. Both number of lesions after mixing and in stable groups are heritable traits *(Desire et al., 2015)*. Recording skin lesions in the front of newly mixed pigs should be feasible in nucleus herds and the records can according to *Desire et al. (2016)* be used to select against both reciprocal and nonreciprocal aggressive behaviour of growing pigs. For sows, direct observations of aggressive behaviour at mixing (after weaning off their litters) as done by *Løvendahl et al. (2005)* seems feasible also on a large scale.

Tail biting

Whether a pig becomes a tail biter or a bitten victim, or takes neither of those roles, depends on the genotype of the pig itself and the genotypes of the group mates (and the environment where the pigs are kept), as explained by *Brunberg et al. (2016)*. Also for this behaviour, being a performer may be more heritable than being a victim, but the behaviour is difficult to record and quantitative genetic studies are scarce. So called neutral pigs are pigs being neither biters nor victims in groups where tail biting is ongoing. *Wilson et al. (2012)* found that some genetic markers were associated with being neutral and others with being biter or victim. Furthermore, *Brunberg et al. (2013)* found that the expression of many genes did not differ between biters and victims, but did differ between those pigs and neutral pigs. The value of neutral pigs in a breeding program aiming for less damaging behaviour should be further studied.

The social model for genetic evaluation

The pen mates may be the most important elements of a pig's environment and their influence (be it positive or negative) is governed by their genotypes. The social model for growth rate (also called the group model) developed by *Muir (2005)* and *Bijma et al. (2007)* includes two genetic effects: a direct genetic effect which explains the pigs' own capacity to grow, and a social (indirect) genetic effect which explains the ability to influence the growth of the pen mates *(Figure 2)*. The social genetic effect on growth rate is probably associated with 'good' or 'bad' behaviour, but behaviour is not described by the social model – the analysed trait is growth rate and records on growth rate and group composition are always available in breeding organisations' data bases. (Other traits can also be analysed with the social model, but for pigs this model has mostly been used for growth rate.) The statistical analysis with the social model is demanding and large data sets are needed. *Bergsma et al. (2008), Chen et al. (2009), Canario et al. (2012), Nielsen et al. (2018)* are some of the researchers that have analysed pig growth rate with the social model.

With the social model, two breeding values are estimated for each pig; a direct and a social breeding value. In a competitive environment where feed is restricted, the correlation between the direct and the social effects is negative and unfavourable. Under such conditions, selection for the direct effect (i.e. individuals' capacity for own growth) will have a negative effect on the growth of pen mates, and likely also on their welfare.

Differences between pigs with high and low social breeding values

The aggressive behaviour of pigs with high and low social breeding values for growth is complex. Pigs with high social breeding values for growth tend to show more aggressive behaviour at mixing, but less later on in stable groups *(Rodenburg et al., 2010, Canario et al., 2012)*. *Canario et al. (2012)* proposed that, in an environment where there is no need to compete for feed and the correlation between the direct and the social breeding value is positive, pigs with high social breeding values initiate and win more fights at mixing which facilitates a rapid establishment of the social rank order within the group.

Once social breeding values for growth rate have been estimated, pigs with high and low social breeding values can be compared in behavioural studies. This study design with the two groups from the two outer ends of the normal distribution can increase our knowledge in behavioural genetics with a limited number of animals, as compared to behavioural studies of a random sample of the whole population. *Camerlink et al. (2013)* found no difference between pigs with high and low social breeding values in number of skin lesions in a re-grouping test. However, when the tested pigs met familiar group mates after 24 h of separation (due to that test) pigs with high social breeding values showed less aggressive behaviour than pigs with low social breeding values. Blood variables from samples taken before and after the re-grouping test indicated that pigs with high social breeding values were less stressed by the test *(Reimert et al., 2014, Dervishi et al., 2018)*. Growing pigs with high social breeding values seem to be calmer, as they spend more time lying down *(Canario et al., 2012)*. *Hong et al. (2018)* found in a small study performed after mixing, that pigs with high social breeding values spent more time on eating and they were more often eating together with pen mates.

Pigs with high social breeding values are less fearful *(Reimert et al., 2014)* and show less biting behaviour *(Camerlink et al., 2015)*. *Hong et al. (2019)* estimated genetic correlations between the social effect on growth of young pigs and longevity and litter size of sows in a very large study. There was no genetic correlation between social effect of growth rate and longevity, but a positive genetic correlation between social effect of growth rate and litter size.

Based on the studies mentioned above, pigs with high social breeding values for growth rate seem to have a more 'adequate'

Figure 1: Pigs are explorative animals but in most pens there is not much to explore. These young pigs at least have some straw (Picture: Svennås-Gillner, SLU)

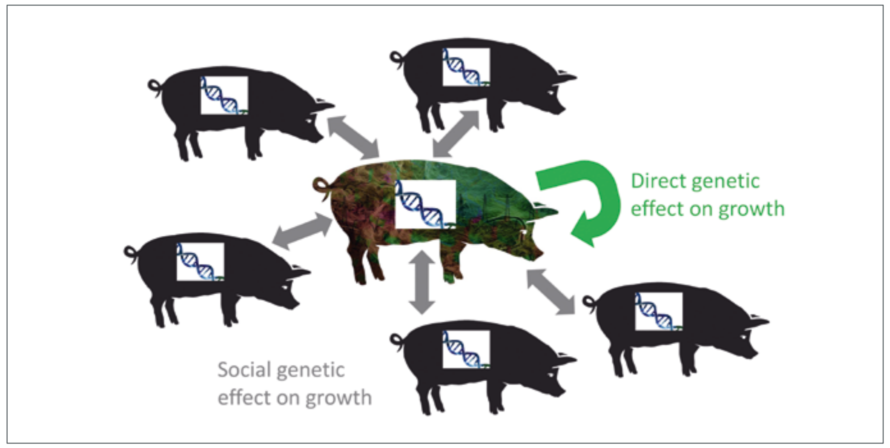

Figure 2: Based on breeding organisations' large data bases, the direct genetic effect and the social genetic effect on growth rate of pigs can be used to estimate direct and social breeding values (Picture: Rydhmer, SLU, pigs from Saarkoppel, SLU)

aggressive behaviour (quickly establishing social rank), be less prone to tail biting, have higher ability to handle stress, be less fearful and have better reproduction.

Taking social and damaging behaviour into account in breeding

The social model can become a valuable tool in breeding. There are also other statistical models under development for behavioural traits, such as social network analysis to account for direct and indirect interactions between animals, and capture-recapture analysis to replace missing data by estimating the probability of behaviours *(Canario et al., 2020)*.

Lack of phenotypic records hinders the inclusion of social and damaging behaviours in the breeding work. Sensors could be used to collect data and with genomic evaluation these data could result in breeding values with high accuracy *(Rodenburg et al., 2019)*. Cameras, accelerometers, timing and positioning systems etc.; the ongoing technical development opens new recording possibilities. These techniques often provide huge amounts of data and thus development of data management and analysis (using e.g. artificial intelligence for image analysis) is also needed.

Tail docking is forbidden in many European countries, but the legal consequences of performing tail docking are apparently not costly enough to change breeding goals (or management routines). Value shifts in society and consumers may not accept tail docking in the near future. This could become a driver for changed breeding goals. A typical pig breeding goal of today includes traits related to production, reproduction, longevity and health. Adding tail biting or aggressive behaviour would reduce the weight given to each trait and may thus reduce the genetic progress in the current traits. Unfavourable genetic correlations between e.g. aggressive behaviour and lean growth rate would further reduce the progress. Even so, the economic value of the total genetic improvement may increase by including tail biting and or aggressive behaviour. At the same time, such a breeding goal would improve animal welfare.

The optimal relative weight given to each trait in a breeding goal is often calculated with a bio-economic model taking costs and revenues into account when estimating the economic value of a genetic change in each trait. Tail biting or aggressive behaviour may, however, be more important for animal welfare than for short-term economic profit at farm level. Thus the economic weights from the bio-economic model ought to be adjusted, but what is the value of improved welfare (in addition to the monetary value)? What is the cost of pain and fear? The genetic progress resulting from alternative breeding goals, where tail biting and aggressive behaviour are included with lower or higher relative weights, can be simulated. Results from such simulations can serve as a base for discussions on breeding goals and weights in relation to fundamental values, within the breeding company and with the company's stakeholders.

Breeding companies aiming for improved animal welfare could select against tail biting and aggressive behaviour. Large-scale recording of these behaviours is indeed complicated, but it is not impossible. As an alternative, the social model could be used to select pigs with high social breeding values for growth rate.

Further reading

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