Behavoural genetics important for pig welfare

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Welfare discussions are often focused on environment and management.

"FAWC is aware that selection for temperament is becoming increasingly important in breeding programmes. This is particularly the case for species such as pigs..."

FAWC, 2004
Aim of this lecture

- Review studies of behavioural genetics with welfare implications
- Discuss possibilities to select for behavioural traits in order to improve welfare
The five freedoms

- Freedom from Hunger and Thirst
- Freedom from Discomfort
- Freedom from Pain, Injury or Disease
- Freedom to Express Normal Behaviour
- Freedom from Fear and Distress

FAWC, 1992
"Freedom from Hunger and Thirst - by ready access to fresh water and a diet to maintain full health and vigour"

Are pigs hungry?
Is appetite a behavioural trait?
Limited milk production decreases piglet welfare

Eissen et al (2000): Select for increased voluntary feed intake of lactating sows

Sows in lactation  2.5 x 4 weeks / year

Welfare impact
• number of animals
• severity
• duration
"Breeding companies, and those responsible for the selection of breeding stock to be kept on outdoor enterprises, must ensure that only those strains of pig with the genetic potential to thrive in the conditions provided are used."

FAWC, 1996
The pig is an omnivorous, opportunistic generalist
Curious and eager to acquire knowledge
- explorative behaviour
Growing pigs are kept in monotonous environments
Breed differences in explorative behaviour
Breuer et al, 2003
"Freedom from Pain, Injury or Disease - by prevention or rapid diagnosis and treatment"

- Tail biting
- Aggression, growing pigs and sows
- Maternal behaviour
Welfare standards of The Royal Society for the Prevention of Cruelty to Animals (RSPCA):

"The genetics of the pigs on a unit can effect the likelihood of tail biting occurring"
Freedom from Pain, Injury or Disease

Tail biting

Difficult to record the biter!

Test: Biting behaviour towards a rope

Duroc show more rope biting (and ear-biting) than Landrace and Large White

Freedom from Pain, Injury or Disease

Breuer et al, 2005

3 % classified as "biters"

injured  
h\(^2\) = 0.0

biting 
Large White  
h\(^2\) = 0.0
Landrace  
h\(^2\) = 0.3

Unfavourable genetic correlations

tail biting - high lean tissue growth rate
tail biting - low back fat thickness
Freedom from Pain, Injury or Disease

Aggressive behaviour of growing pigs

Pigs mixed at
• weaning
• entry growing-finishing pen
• transport to abattoir
• at abattoir

"Breeding Organisations ensure the health and welfare of the animals they keep and select, so that pain and suffering are minimised; this may include selection against aggressive behaviour between animals."

Code EFABAR
Aggressive behaviour of growing pigs

24 h video recording after mixing

Turner et al (2009)

Fighting (reciprocal) $h^2 = 0.4$
Bullies, deliver $h^2 = 0.3$
Bullies, receive $h^2 = 0.1$

Fighting and deliver bullies $r_g = 0.8$
Fighting and receive bullies $r_g = 0.0$
Deliver and receive bullies $r_g = -0.4$
Freedom from Pain, Injury or Disease

Pigs selected for high lean tissue growth rate are more aggressive during transport  
Busse & Shea-Moore (1999)

Social rank during feeding ($h^2 = 0.5$) is genetically correlated to growth rate  

Schinkel et al (2003) propose: Selection for growth results in increased aggressiveness

Canario et al (2008): High breeding values for growth rate initiate more fights and bullies
To estimate breeding values for unfavourable behaviours without recording behaviour

the group model  
Muir (2005)

Two genetic effects:
• direct (own growth)
• associative (influence on pen mates growth)

Correlation between direct and associative effects

Quails compete  
(Muir, 2005)

Pigs cooperate  
(Bergsma et al, 2008)

Chen et al, 2008)
Group model and behavioural data from study of Turner et al, in Swedish nucleus herd

Pigs with high breeding value for associative effect at mixing:
- initiated more fights
- won more fights
- gave more bullies
- lost more fights

3 weeks later:
- no effect on skin lesions in the front
- more skin lesions in the rear
- spent less time standing

Canario et al (in prep)
Group model and behavioural data from study of Turner et al, in Swedish nucleus herd

We conclude:
aggressive behaviour at mixing (ability to quickly establish rank order)
• is not necessarily a "bad behaviour"
• is probably not correlated to aggressive behaviour once rank order is established

Canario et al (in prep)

Two kinds of aggressive behaviour
• brief period of intensive fighting when mixed
• longer-term competition over limited resource

Fraser (1984)
Favourable genetic correlation between direct and associative effects - cooperation

Cooperation's role in evolution seems controversial - Sachs et al, 2004

Only cooperation between relatives fits in the theory of the selfish gene - Dawkins, 1976

Natural selection → selfish individuals successful at expense of group members - Denison et al, 2003

Breeding ≠ Natural selection

Cereal yield increased by reducing stem length - no chance in competition with wild type - Jennings & de Jesus, 1968
Cooperative pigs?
Pigs staying calm, eating without disturbing group members → high EBV for direct and associative effects
- if feed resource is unlimited (?)

Proposed future study:
EBV for direct and associative effects in various environments with
• more or less restricted feeding
• larger or smaller group size
Another interesting study...
Direct and associative genetic effects on weaning-to-oestrus interval, oestrous symptoms or pregnancy rate in **loose housed sows**

"selection for temperament is becoming increasingly important ... for species such as pigs and laying hens where a move away from close confinement systems, driven by either legislation or market forces, has revealed the importance of behavioural traits such as reduced levels of aggression."

FAWC, 2004
Aggressive behaviour of loose housed sows

Aggressive behaviour recorded in field study
Sows mixed in a "test arena" during pregnancy
Groups of 8 sows studied for 30 min.
800 sows

Individual records
• attacks given
• attacks received

Lövendahl et al, 2005
Freedom from Pain, Injury or Disease
Freedom from Pain, Injury or Disease

Animal model with two genetic effects

All interactions within all dyads of sows in test group

\[ y = \text{env.} + \text{genetic} + \text{genetic} + \text{random} \]

Effects attacking receiving

Give attack \( h^2 = 0.09 \)
Receive attack \( h^2 = 0.02 \)

Much simpler:
Record only sum of given attacks \( h^2 = 0.22 \)

Only one genetic effect in the model

Lövendahl et al, 2005
Aggressive behaviour of loose housed sows

Helbrügge et al (2008) recorded aggressiveness in groups of pregnant sows during washing before farrowing

18 % of sows aggressive
threshold model
h² = 0.3

Helbrügge et al (2008) and Lövendahl et al (2005) found favourable genetic correlations:
less aggression - better maternal behaviour
Good maternal behaviour, for piglets' freedom from pain, injury and death

Infanticide is highly heritable  
Knap & Merks, 1987

Several QTL found  
Quilter et al, 2007

Doctoral thesis by Congying Chen, 2007  
"Towards the genetic dissection of the complex maternal infanticide behaviour using a white Duroc × Erhualian pig F2 design"
Freedom from Pain, Injury or Disease

**Maternal behaviour - carefulness**

Crushing and sows' reaction to screaming piglets are heritable traits

Genetic correlation:
  stronger reaction - lower mortality

Maternal behaviour - fearfulness

Sows' fear of humans is heritable

Genetic correlation: less fear - lower mortality

Grandinson et al, 2003
"Freedom from Fear and Distress - by ensuring conditions and treatment which avoid mental suffering"

<table>
<thead>
<tr>
<th>Fear of humans or attitude to people</th>
<th>$h^2$</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gilts</td>
<td>0.4</td>
<td>Hemsworth, 1990</td>
</tr>
<tr>
<td>Gilts</td>
<td>0.1</td>
<td>Helbrügge et al, 2007</td>
</tr>
<tr>
<td>Sows</td>
<td>0.1</td>
<td>Grandinson et al, 2003</td>
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<td>Sows</td>
<td>0.1</td>
<td>Vangen et al, 2005</td>
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<td>Sows</td>
<td>0.1</td>
<td>Gäde et al, 2008</td>
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<tr>
<td>Minipigs</td>
<td>0.1</td>
<td>Köhn et al, 2009</td>
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Pigs selected for high lean tissue growth rate were less active in **open field test**

Shea-Moore, 1998

Carriers of the RYR(1) allele were also less active in open field test

Fàbrega et al, 2004
New study by Velie et al (2009): "Genetic relationships among pig behavior, growth, backfat, and loin muscle area"

**Backtest**

- Total time spent struggling $h^2 = 0.3$
- Total number of attempts to struggle $= 0.5$

Struggling in backtest was correlated to body weight at 140 days $r_g = 0.2 - 0.4$

$r_p = 0.0$

Unfavourable genetic correlation, if much struggling = not coping with stress
Genetic studies of stress, welfare... and meat quality
Reviewed by Terlouw (2005)
Duroc pigs touched humans more often than Large White pigs did, but got higher heart rates
Are Duroc pigs less fearful or more motivated to touch humans?
Impact of stress response on meat quality is breed dependent
"Selective breeding programmes may cause animal welfare problems ... offspring produced by selective breeding for certain specific characteristics may be unable to express their natural behaviour."

FVE, 1999

What is normal behaviour?
What is natural behaviour in domestic animals?
Segerdahl (2007) proposes that the emphasis on "natural behaviour" is initiated by our moral reaction rather than a biological concept.

Further complication: Natural (and normal) behaviours are sometimes "bad behaviours"
To discuss: Easy care animals

Selecting for behavioural traits
"Do you want to transform pigs into carrots?"

Changing "the intrinsic characteristics"
Select "easy care animals" — we don't have to care

"Staying good while playing God"

Sandö et al, 1999
Recommendations

• Select sows for less aggression in groups
• Select pigs against fear of humans? Or select stockpeople... (Hemsworth, 2008)
• Selection for piglet survival and growth (direct and maternal effects) is easier than selection for maternal behaviour
• Use the group model for genetic evaluation? Wait!
References
FVE, 1999. FVE policy on Genetic modifications in Animals. www.fve.org


