Effects of perinatal environment on later life resilience in farm animals

Bas Kemp, Henry van den Brand, Aart Lammers, J. Elizabeth Bolhuis

Chair group Adaptation Physiology

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CAWA
Centre of Animal Welfare and Adaptation

Foetal origin of adult disease (DPJ Barker)

Coronary heart disease and type 2 diabetes may originate from low birth weight and fetal undernutrition.

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Available online at www.sciencedirect.com
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Reproductive Toxicology 20 (2005) 345–352

Reproductive Toxicology

www.elsevier.com/locate/reprotox

Review

Prenatal exposure to the Dutch famine and disease in later life: An overview

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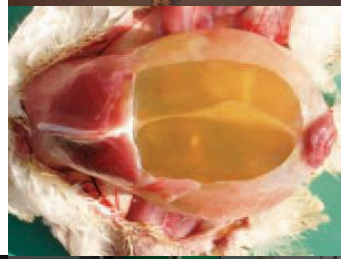
Farm animal issues that may be have a perinatal origin

- Feather pecking in laying hens
- Ascites in broilers
- Weaning and tail biting in piglets
- Performance and health in broilers



Examples of perinatal conditions on later resilience

- Prenatally
  - Stress in the mother hen
  - Incubation temperature in chickens
  - Flavour learning in pigs
- Early postnatal
  - Early feeding in chickens
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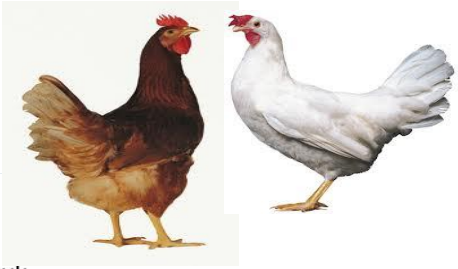
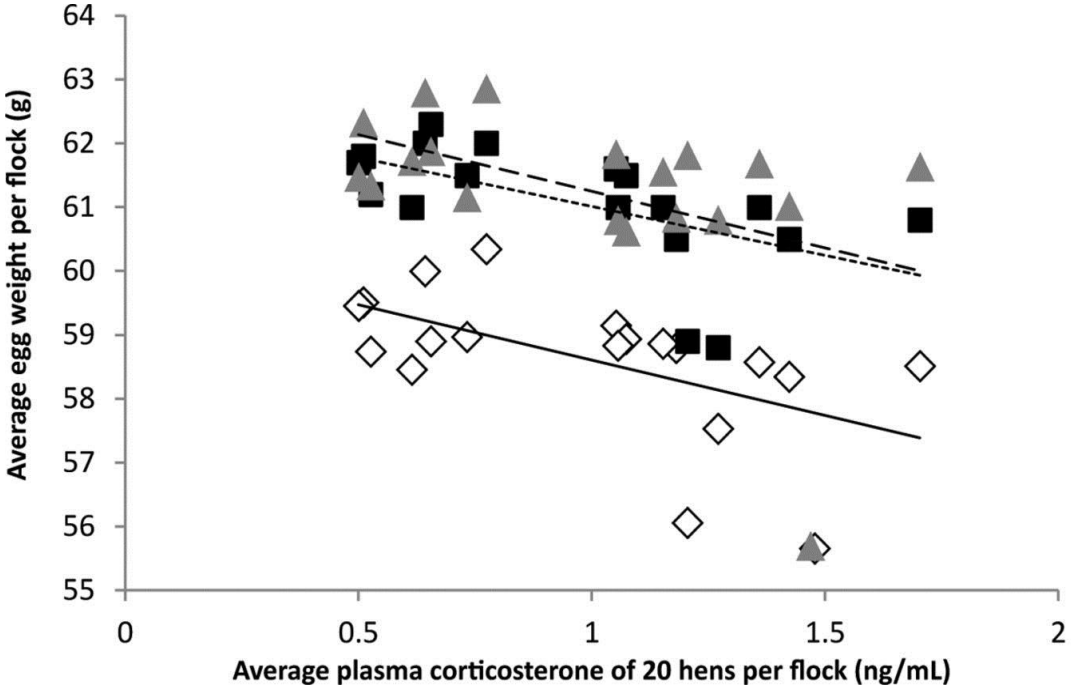
Effects of Parent stock stress on offspring: A comparison at group level

PhD Elske de Haas, 2014

Effects of stress in the parents





Higher basal cort: lower egg weight

(De Haas et al., Poultry Science 2013)

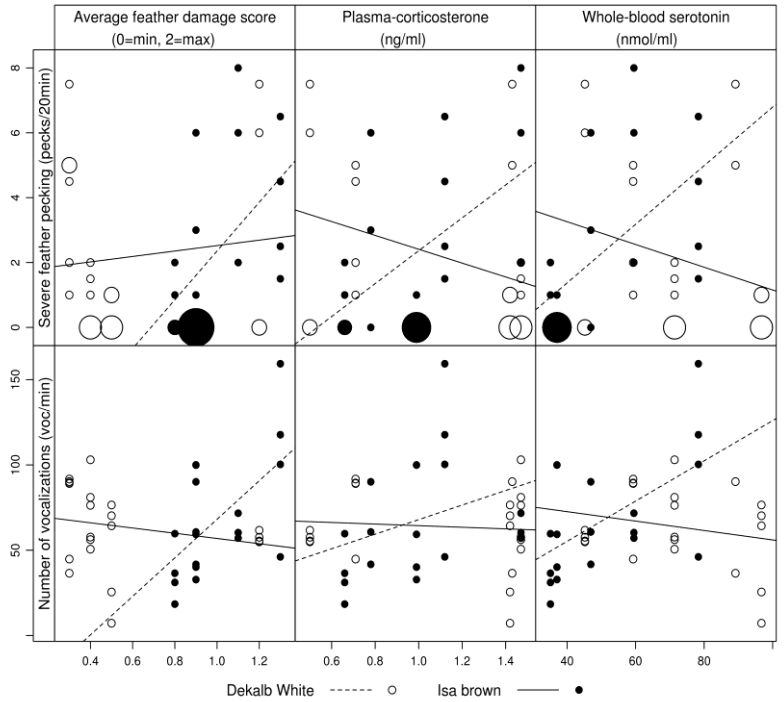
Lower egg weight: smaller, less competitive chicks

(Hendriksen et al, 2013)

Effects of stress in the parents

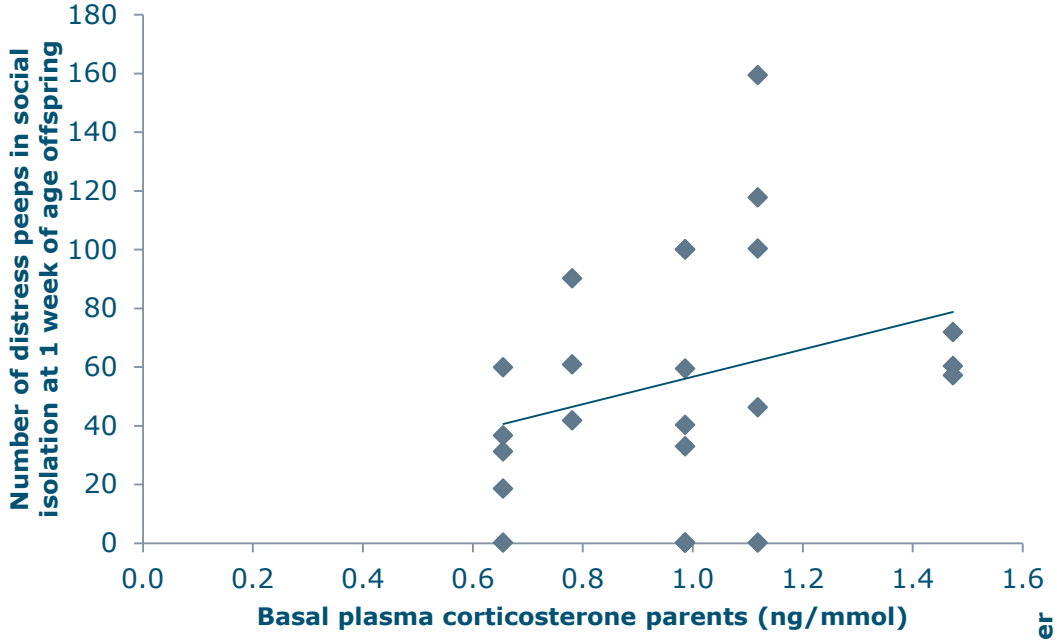
- White parent stock with:
  - High feather damage
  - High basal corticosterone
  - High blood serotonin
- Offspring with:
  - High severe FP wk 1
  - High number of vocalisations isolation test

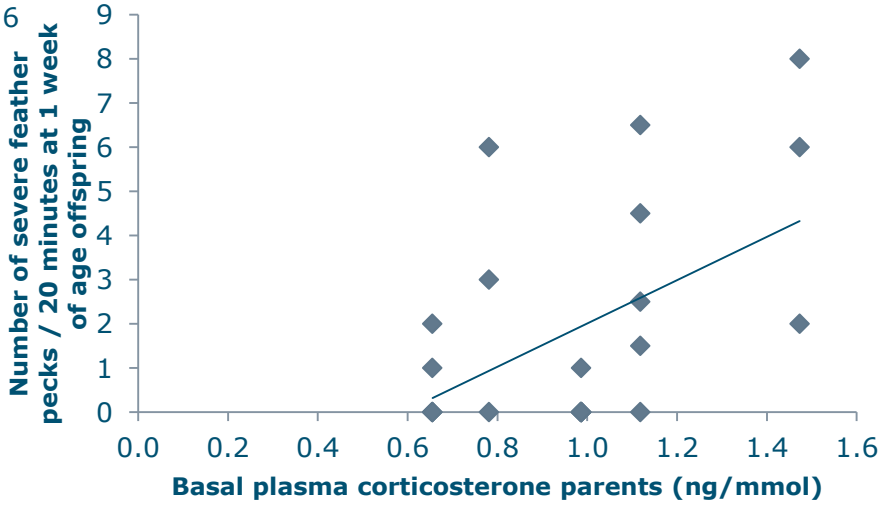
Maternal



Offspring

(De Haas et al., Plos One, 2014)





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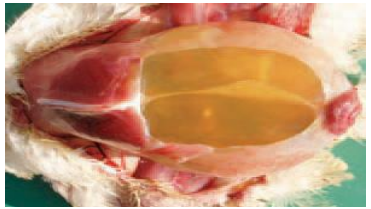
High temperature during late incubation

	37.8°C	38.9°C
YFBM (g)	36.9[a]	33.9[b]
Heart (%, YFBM)	0.38[a]	0.28[b]
Total mortality (%)	8.4[a]	12.5[b]
Ascites related mortality (%)	2.8[a]	6.6[b]

(37.8 vs 38.9 ^{0}C from days 7-19 of incubation)



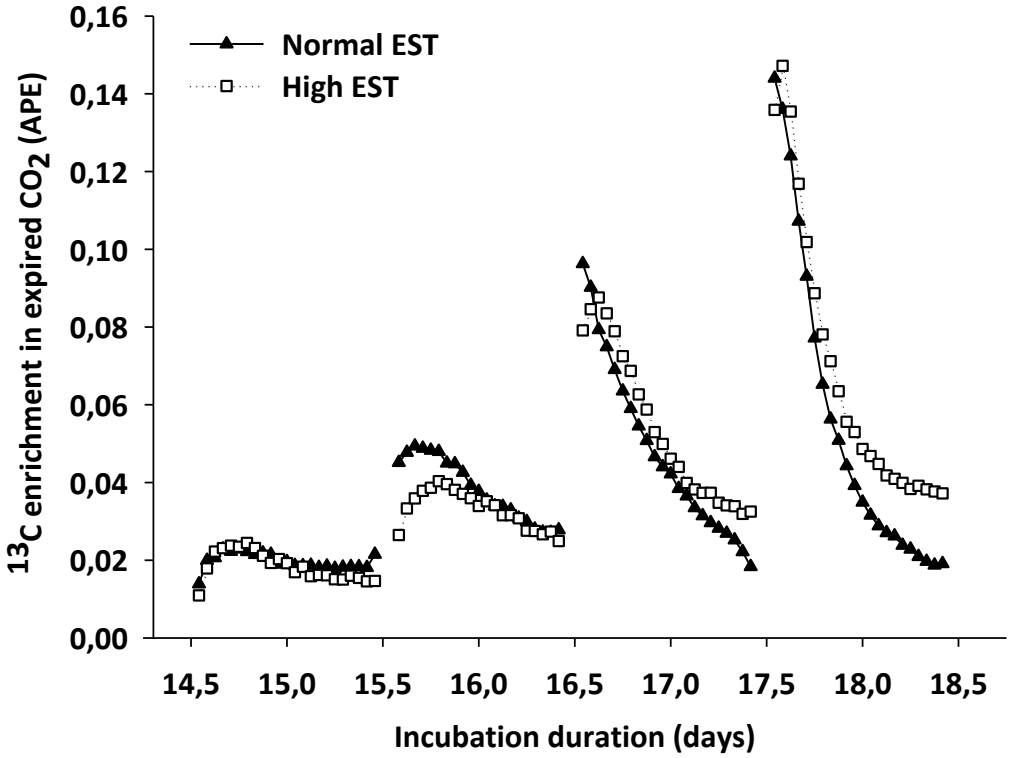
Molenaar et al., 2011, Poultry Science

High temperature during late incubation I

Incubation temperature ↑

Heat production ↑

Glucose requirements ↑



(37.8 vs 38.9 ^{0}C from days 7-19 of incubation)

Molenaar et al., 2013, PloS One

High temperature during incubation

Incubation temperature ↑

Metabolic rate ↑

Glucose needs ↑

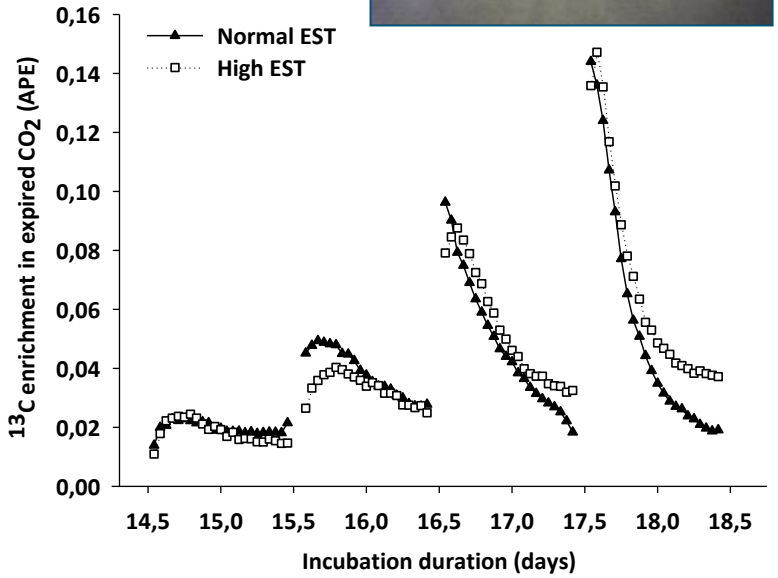
Glycogen reserves ↓

Protein ret. efficiency ↓

Urid acid levels ↑

Heart size ↓

Mortality due to ascites ↑



From science to innovation:

- Control incubator temperature settings based on Egg shell temperature and not machine temperature
- Better ventilation systems that prevent hot spots in incubator
- From multi stage to single stage incubator systems

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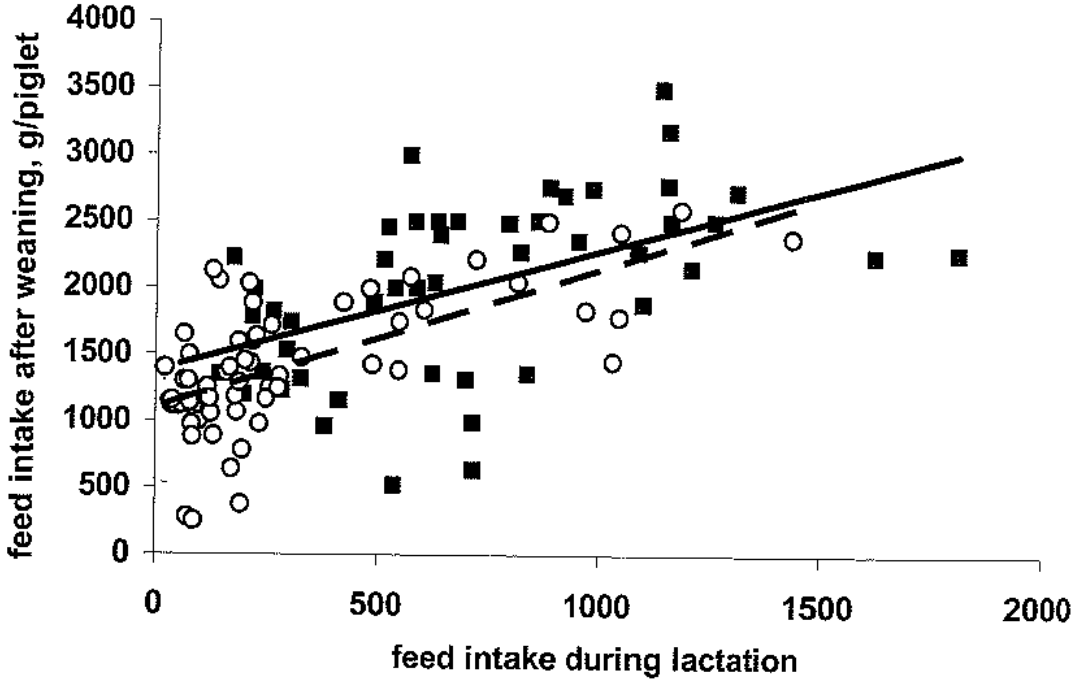
Problems associated with weaning of pigs

- Health and performance
  - **Low nutriënt intake**
  - Poor growth rate or even weight loss
  - Impaired intestinal functioning, diarrhoea
  - Use of antibiotics
- Welfare
  - Stress responses
  - Maladaptive behaviours

Feed intake before and after weaning



27 days lactation, creep feed from 7 days, feed intake after weaning first 7 days (g/piglet)

Kuller et al., 2004, JAS

Weaning

- Weaning: abrupt event
- At 3-4 weeks
- Little experience with solid food

- Weaning: gradual process
- Ends at 8-20 weeks
- Food exploration starts early!

Prenatal flavour learning to reduce weaning problems in piglets

flavours maternal diet via amniotic fluid, milk

↓

exposure piglets *in utero*

↓

flavour recognition

↓

preference flavour ↑

↓

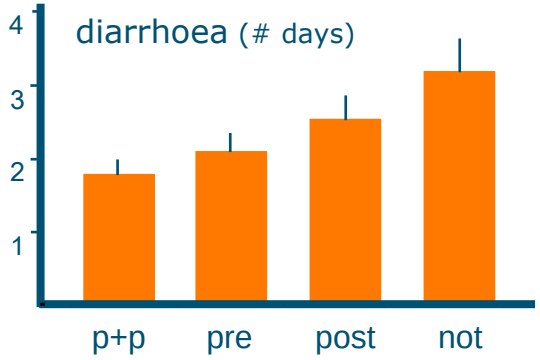
food neophobia ↓ ← stress ↓

↓

feed intake at weaning ↑

↓

Growth ↑, diarrhoea ↓
damaging behaviours ↓



PhD Marije Oostindjer

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Prenatal flavour learning...

Can it be used as a tool to improve piglet performance, health and welfare at weaning?

- → Flavour preference
- → Reduction of stress

Flavour learning & performance postweaning

- Piglets prenatally exposed to flavour sow's feed
  - → lower cortisol response and less vocalisations
  - → higher feed intake and higher growth
  - → less diarrhoea and less damaging behaviours

… if flavour was present in postweaning environment



Bolhuis et al. 2009 VFI in Pigs;
Oostindjer et al. 2009 Chem Sens; 2010 Physiol Behav; 2011 PLoS ONE

From science to innovation

- Provide similar flavoured feed for sows and piglets

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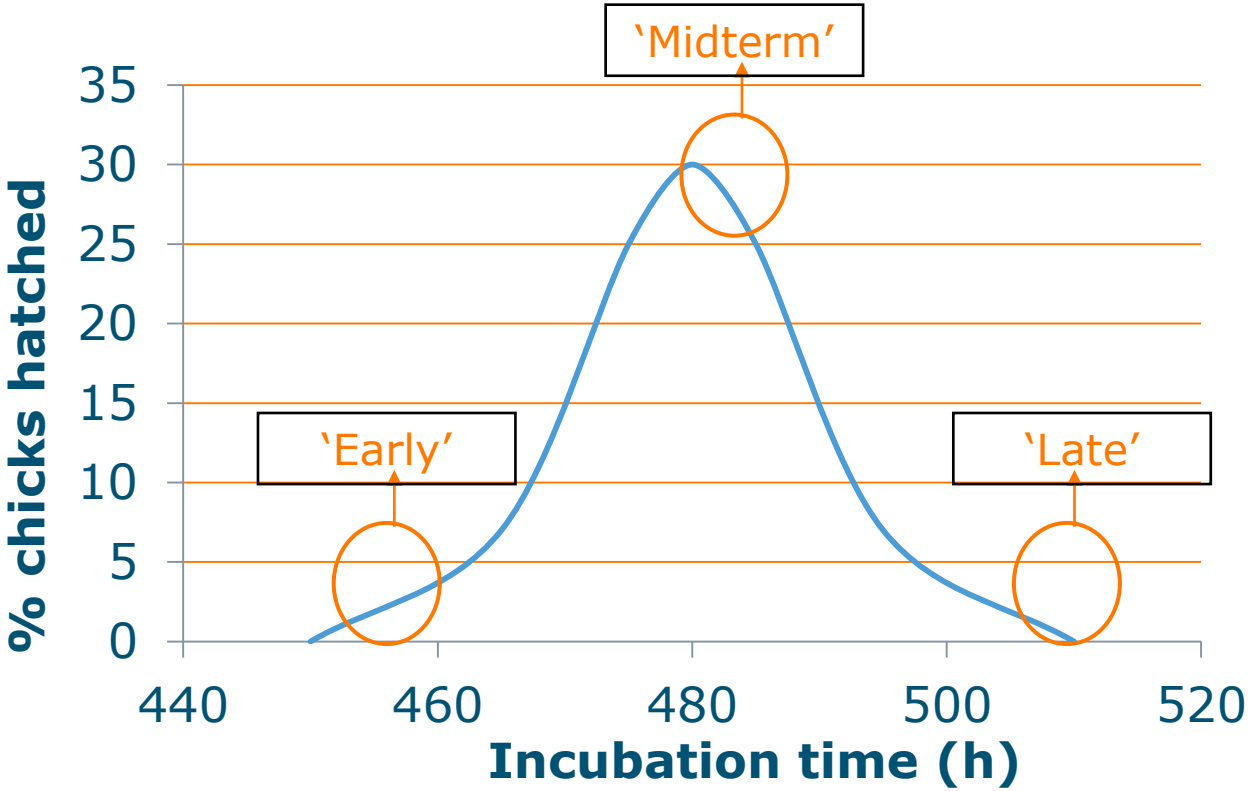
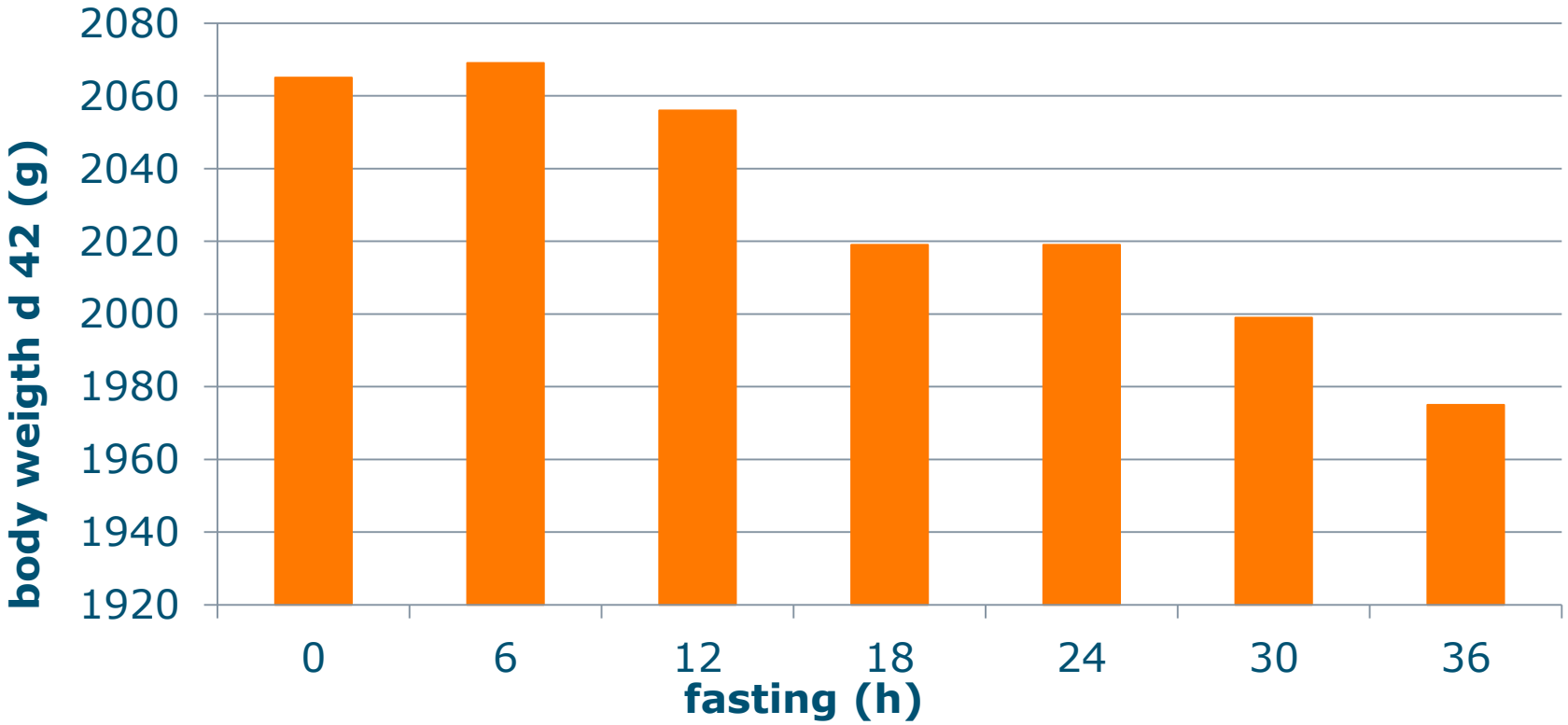
Early feeding

Hatching window



Early feeding and body weight



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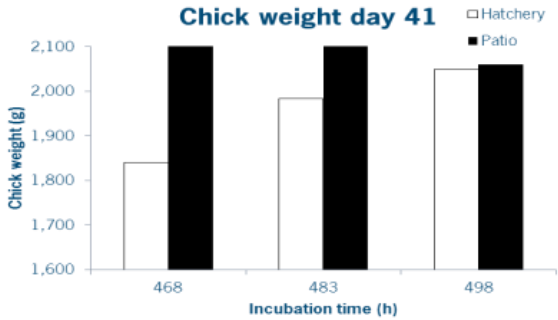
Gonzales et al., 2003

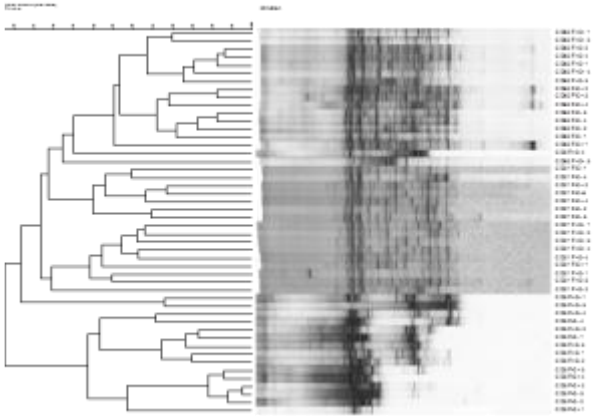
Early feeding after hatch

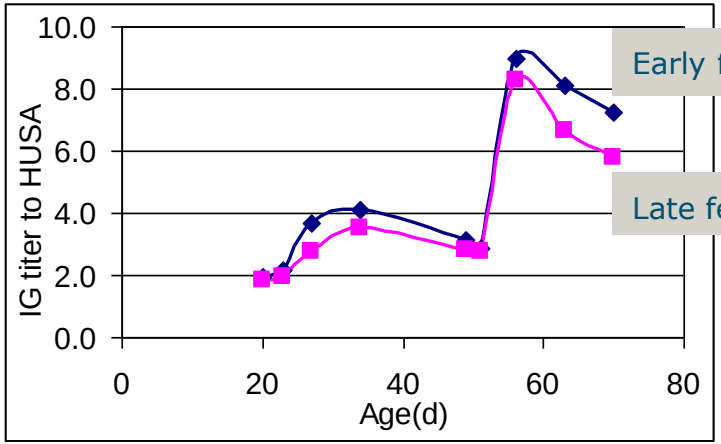
Growth performance ↑

Immune response later life ↑

Long term effects microbiota composition







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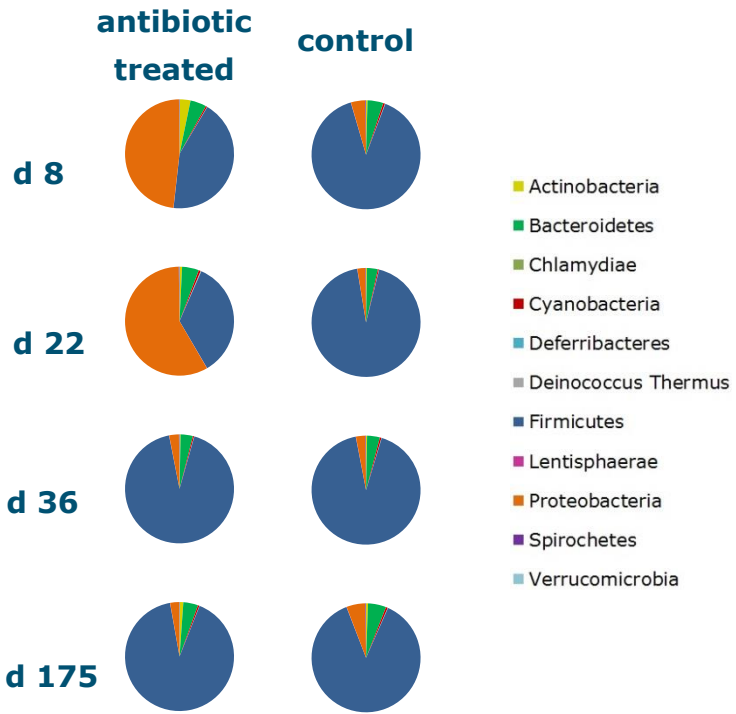
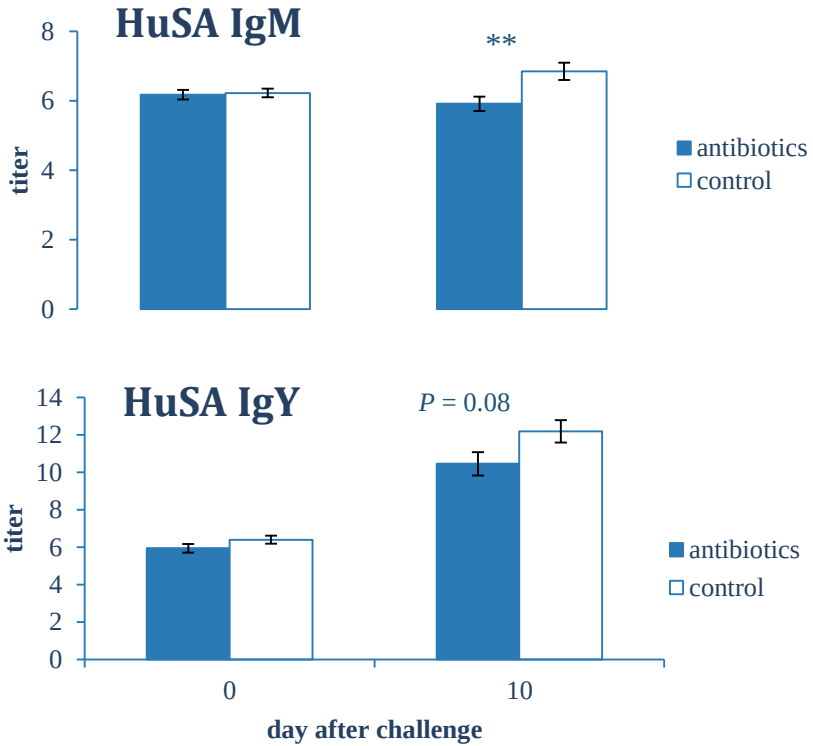
PhD Irene Walstra, Lotte van de Ven

Antibiotic treatment and HuSA effects



challenge with HuSA (T cell dependent) on d 105

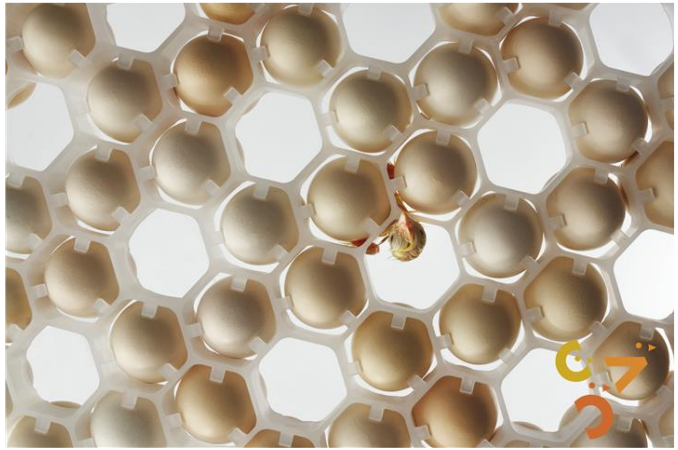


Simon *et al.* 2015, in prep.

From science to innovation

Patio, Vencomatic

HatchCare, Hatchtech



X-track, Vencomatic

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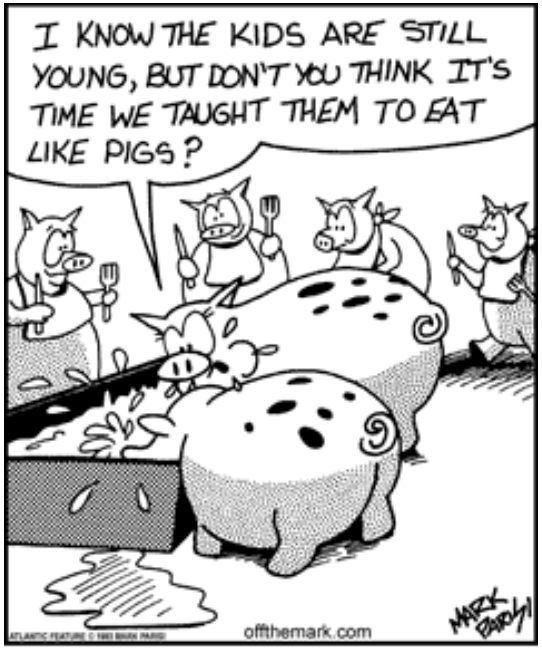
Learning how to eat like a pig

Do piglets learn for mom what & where to eat



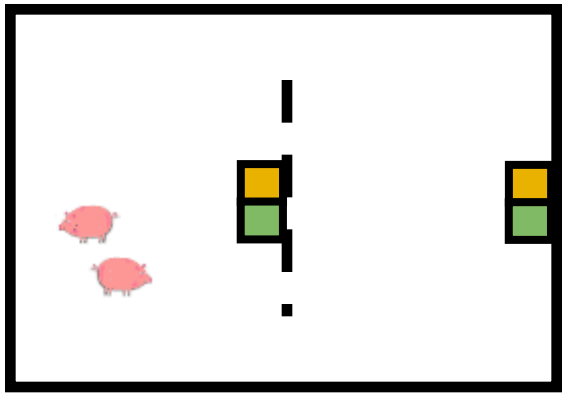
More interactions with the sow

- In the presence of the sow
  - → Reduced food neophobia
  - faster to touch the food (19 vs. 111 s)
  - consumed more food items (6.3 vs. 4.6)
- Loose-housed sow
  - → Higher pre-weaning growth
  - → Less damaging behaviours & more play behaviour after weaning

Oostindjer et al, 2010 Biol Lett; 2010 J Anim Sci

Social learning: processes and cues

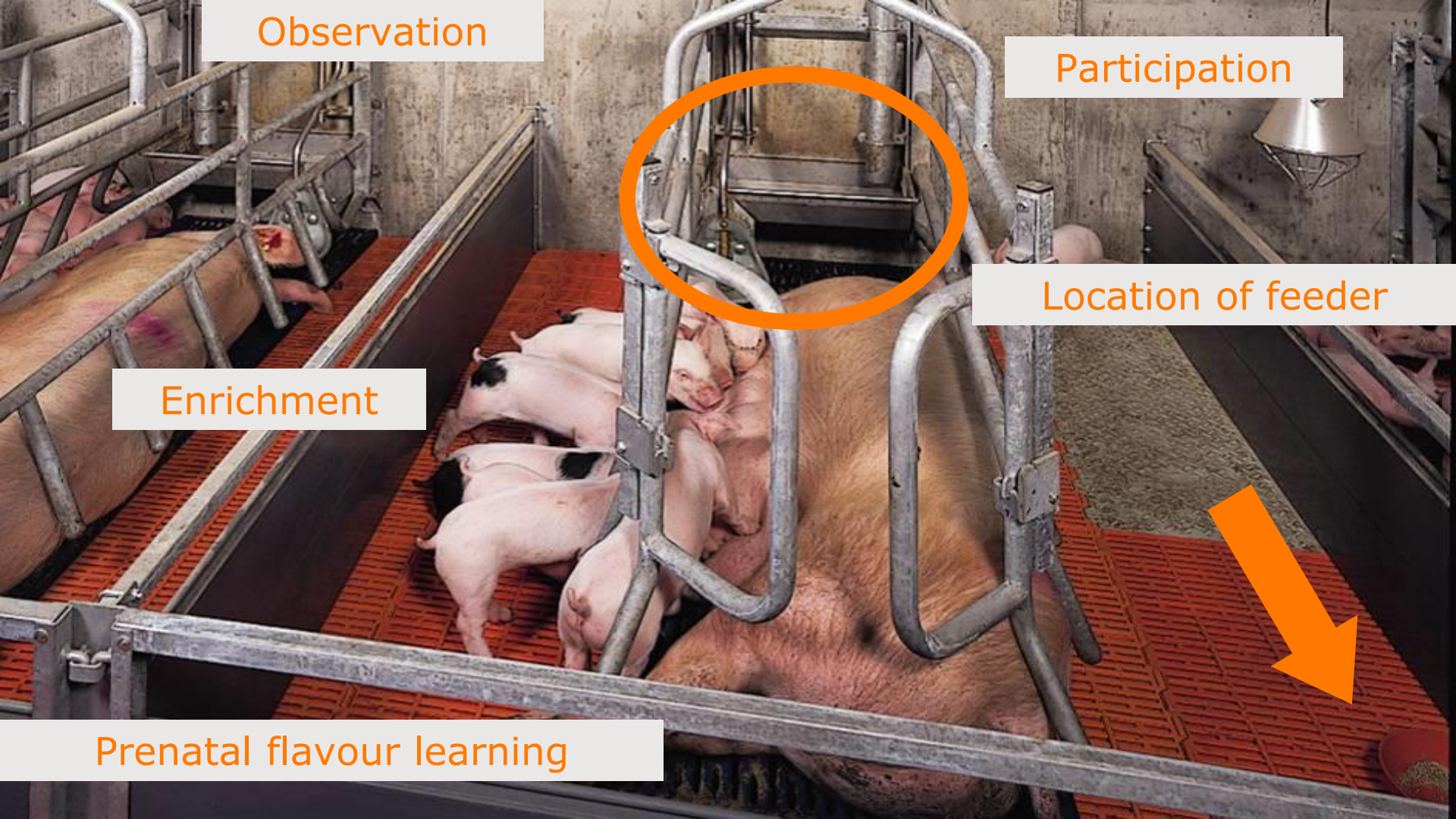
- Observing sow and participating with sow both effective
  - Higher feed intake than controls, start to eat sooner
  - Preference for sow's feed and feeder
  - Observing sow more effective than own exposure to food!



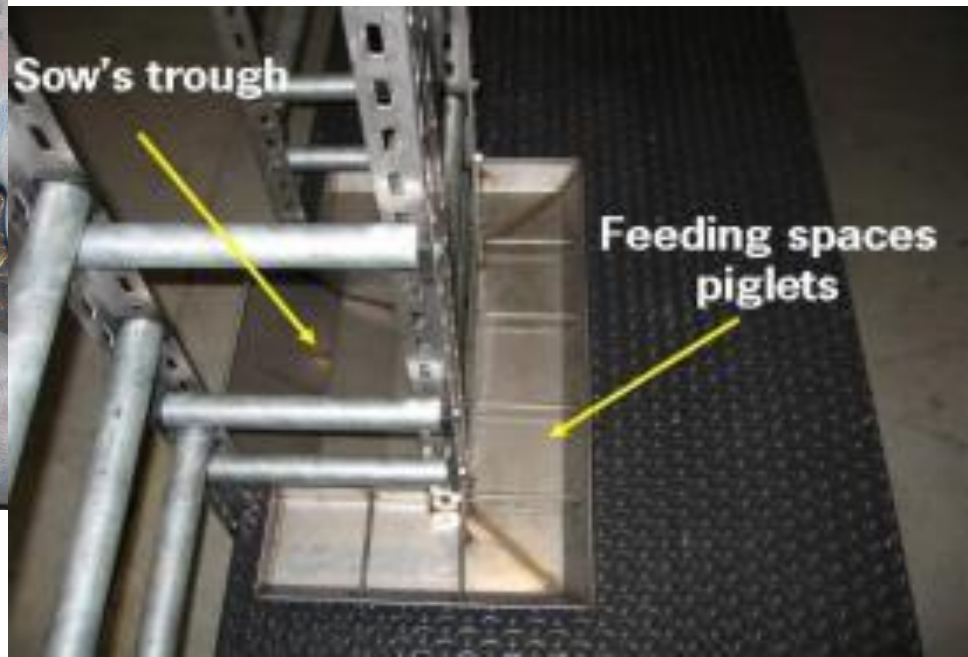
Oostindjer et al. 2011, Anim. Beh.

Conclusions on processes and cues in social learning

- Piglets should be able to participate in or at least to observe the sow eating
- Piglets prefer a similar flavoured sow feed
- Piglets prefer to eat at the same feeder as the sow


Observation
Participation
Location of feeder
Enrichment
Prenatal flavour learning

From Science to innovation



Science to innovation (lactation group housing)

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Take home messages

- The perinatal environment has substantial effects on later life health welfare and performance
- In housing and management of animals in early stages of life effects on later resilience need to be considered
- To optimize life time performance a whole chain approach is needed

Thank you

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