Gut microbiota and feather pecking

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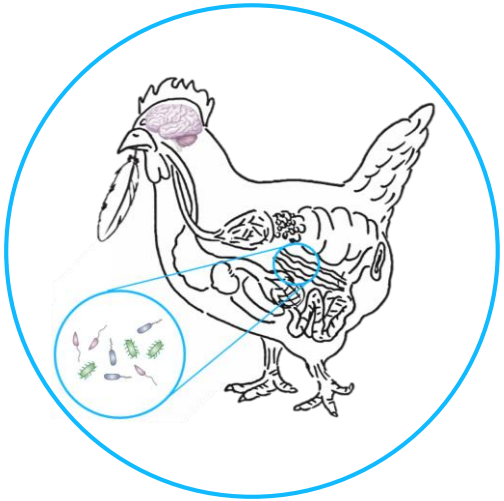


WAGENINGEN
UNIVERSITY & RESEARCH

100years
1918 — 2018

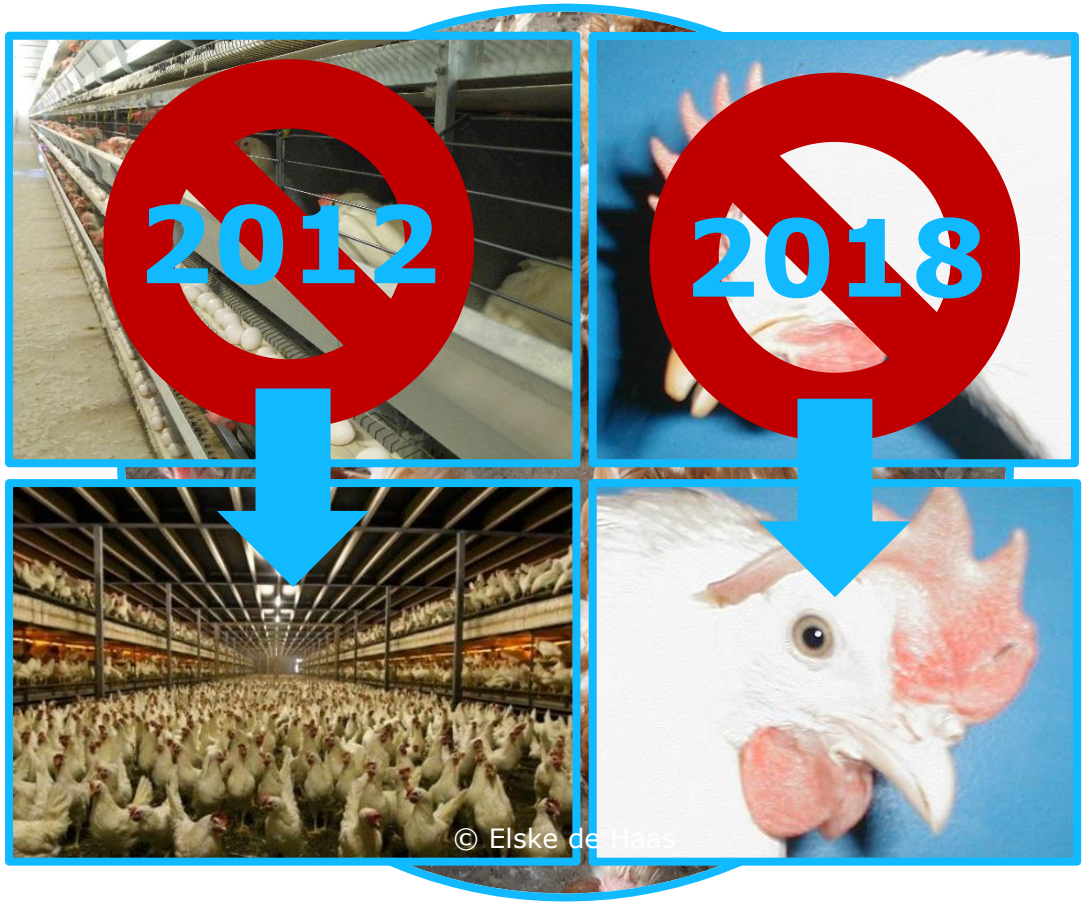
Feather pecking

Feather pecking =

damaging behaviour

↓ Animal welfare

↓ Productivity



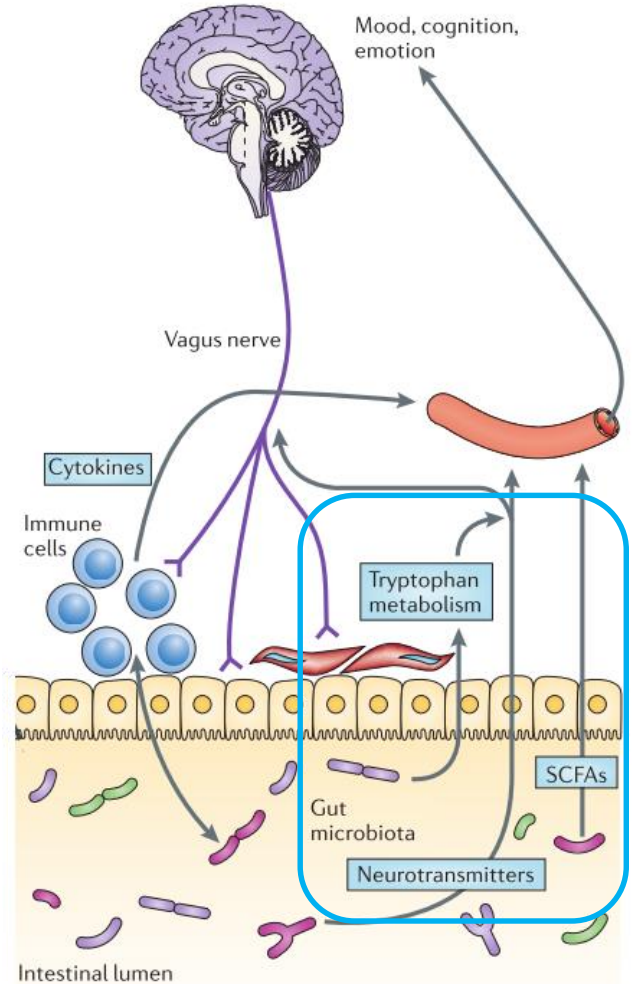
Alternative solutions!

Gut microbiota

Brain development and function

(Cryan and Dinan, 2012;Collins et al., 2012)

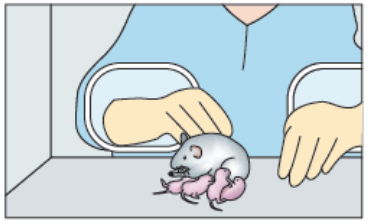
- Neural: vagus nerve
- Immunological: cytokines
- Metabolic: tryptophan metabolism, short chain fatty acids (SCFA's), neurotransmitters



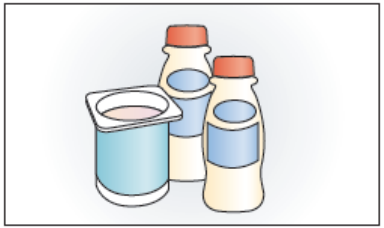
(Cryan & Dinan, 2012)

Gut microbiota - Rodents

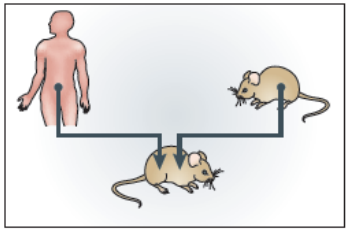
Germ-free rodents

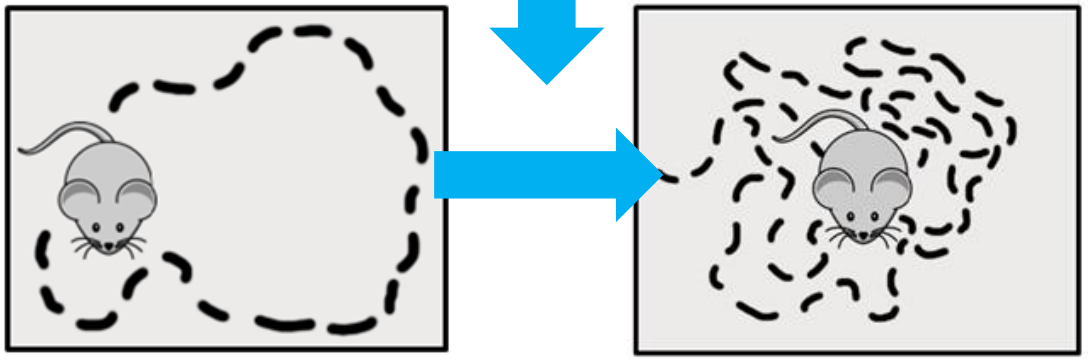


Anti-, pre- or probiotics



Microbiota transplantation

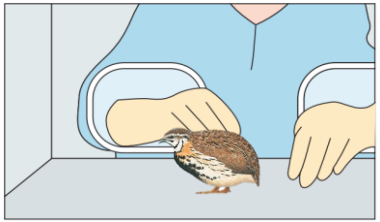




(Cryan & Dinan, 2012 and Collins et al., 2012)

Gut microbiota - Poultry

Germ-free quails



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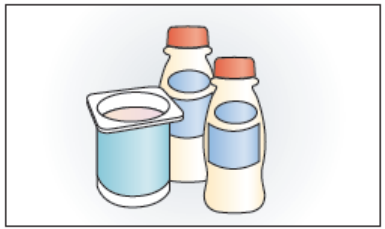
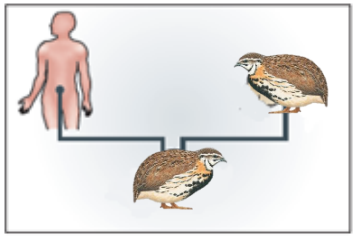


Microbiota transplantation



Behaviour: fearfulness and activity

(Kraimi et al., 2018;2019; Parois et al., 2017)

Gut microbiota – Feather pecking

Feather pecking related to activity (Kjaer et al., 2001), cleanliness

High feather pecking line

Low feather pecking line

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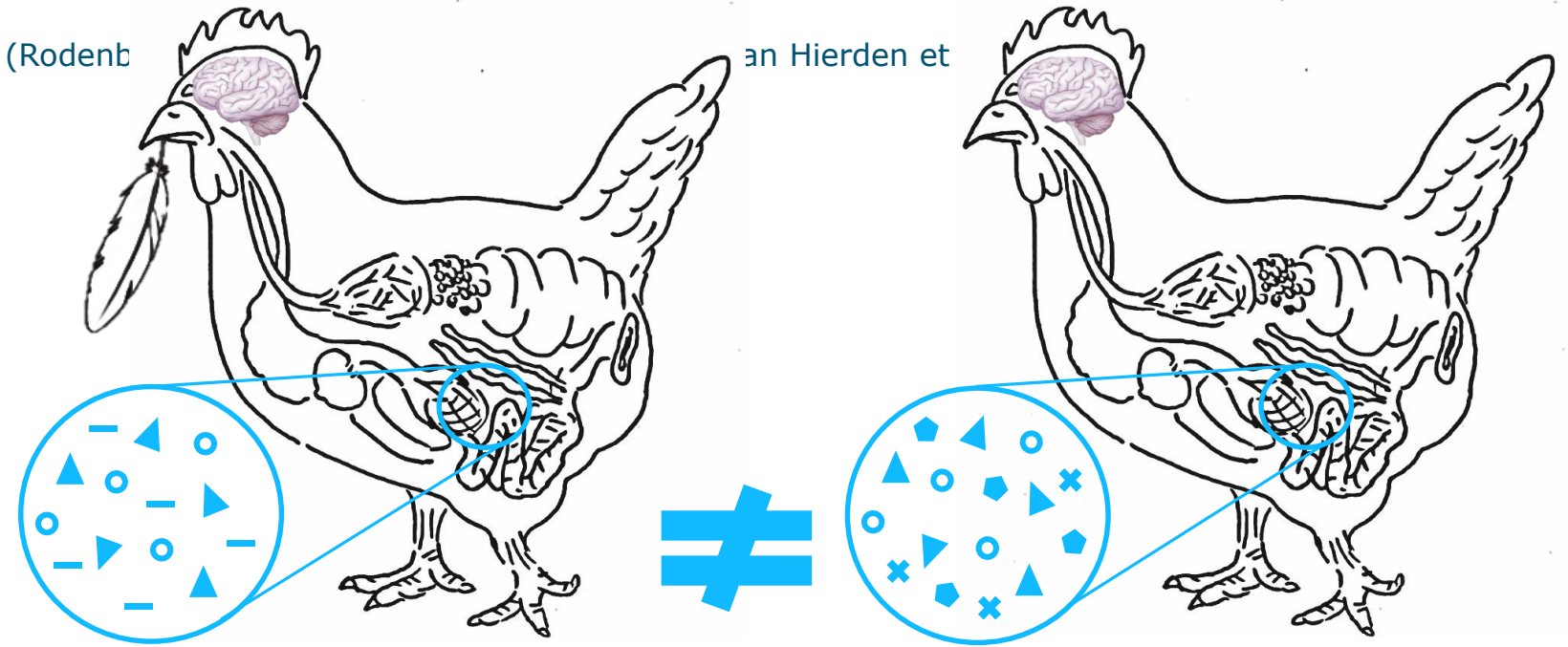


(Meyer et al., 2013)

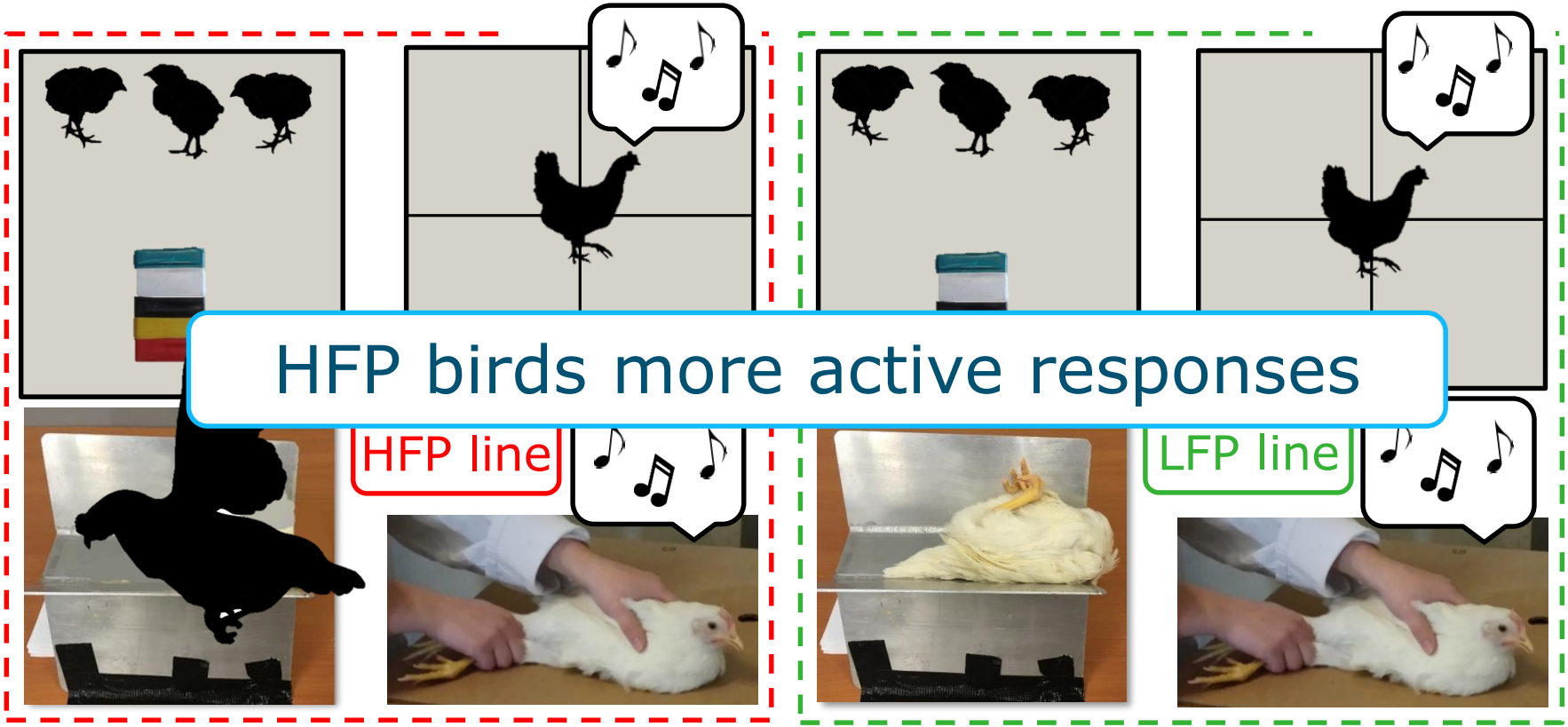
Aim

Identify effects of gut microbiota on feather pecking

1) Do feather pecking selection lines differ in gut microbiota composition?

- Characterize behavioural characteristics and microbiota composition of HFP and LFP lines

Behavioural characteristics: HFP vs. LFP

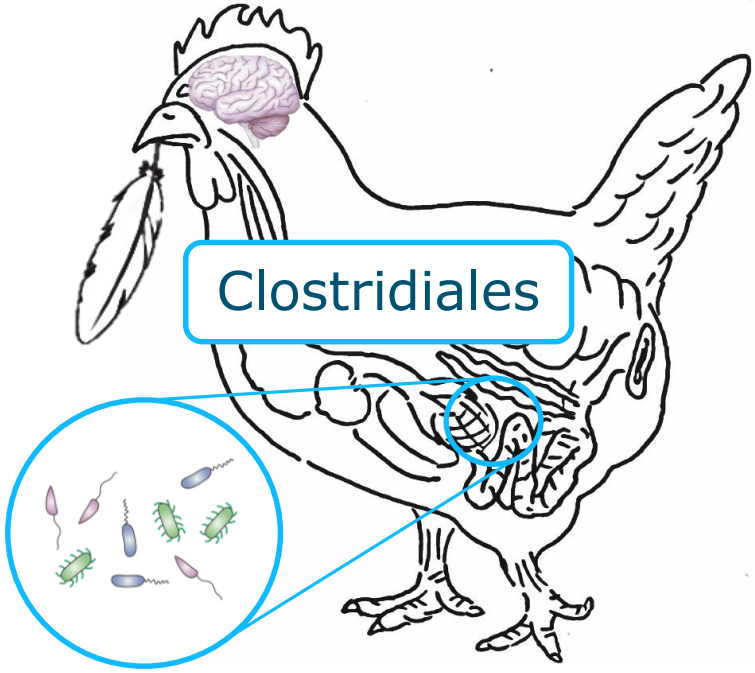


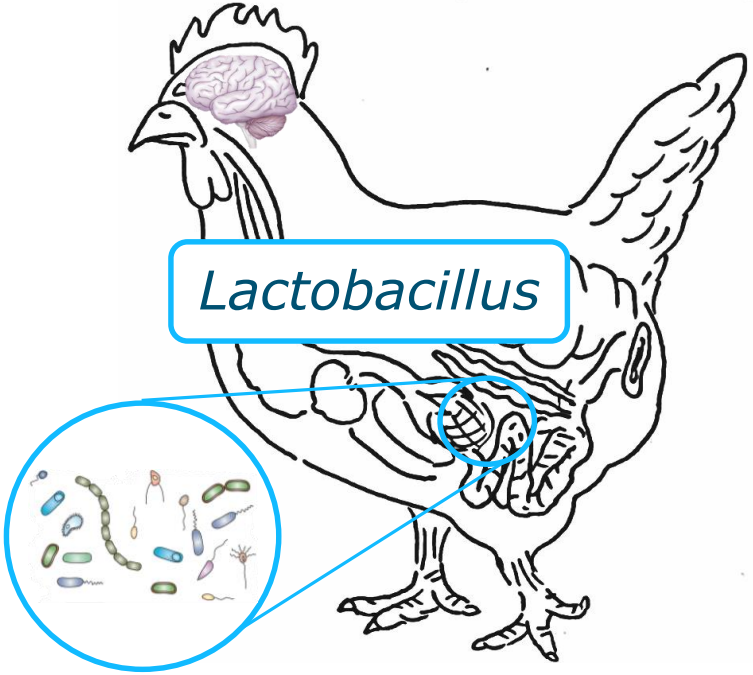
(Kops et al., 2017; van der Eijk et al., 2018; 2019)

Gut microbiota composition

High feather pecking line

Low feather pecking line





(Birkl et al., 2018; van der Eijk et al., 2019)

Discussion

HFP birds had more active behavioural responses (de Haas et al., 2010; Kops et al., 2017; van der Eijk et al., 2018; 2019) → suggests ↓ fearfulness (Forkman et al., 2007)

Feather pecking usually related to ↑ fearfulness (Rodenburg et al., 2013)

Behavioural responses might be related to activity level

HFP birds higher locomotor activity in home pen (kjaer et al., 2009)

Altered intrinsic motivation (Toates 1986) → leads to more locomotion

Discussion

Microbiota composition influenced by many factors (for example, genotype and diet) (Sport et al., 2011)

Consistent findings across studies (birkl et al., 2018; van der Eijk et al., 2019) → strong influence of genotype?

Differences might arise because of feather eating → HFP birds ingest more feathers (Harlander-Matauschek and Bessei 2005; Harlander-Matauschek and Hausler 2009) → feathers in diet altered microbiota composition ↑ clostridia (Meyer et al., 2012)

Conclusion

Divergent selection on feather pecking (in)directly affects behavioural responses and microbiota composition

- HFP birds more active behavioural responses, reduced fearfulness, compared to LFP birds
- HFP birds more clostridiales, less lactobacillus compared to LFP birds

Aim

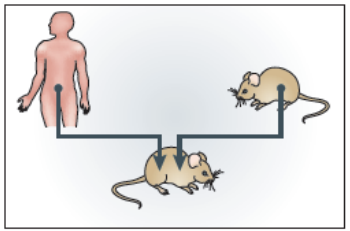
Identify effects of gut microbiota on feather pecking

1) Do feather pecking selection lines differ in gut microbiota composition? - YES

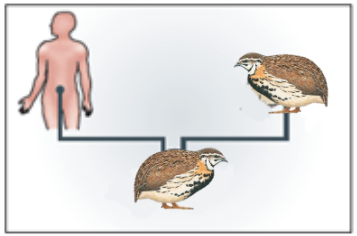
2) Does gut microbiota influence the development of feather pecking?

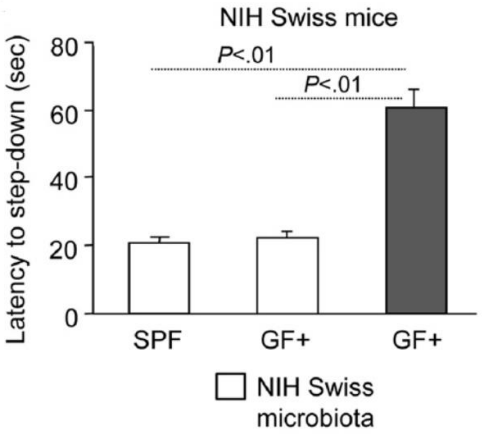
Microbiota transplantation

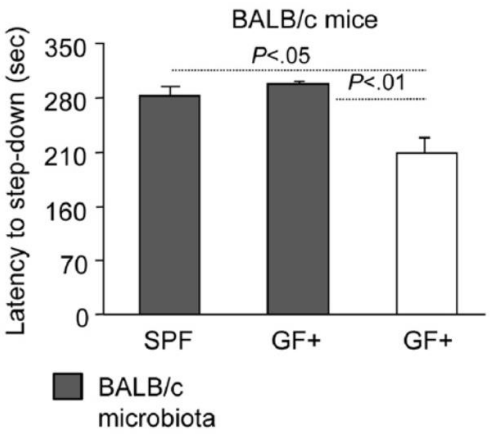
Rodents



Quails







(Cryan & Dinan, 2012; Collins et al., 2012; Kraimi et al., 2019)

Hypothesis

Microbiota

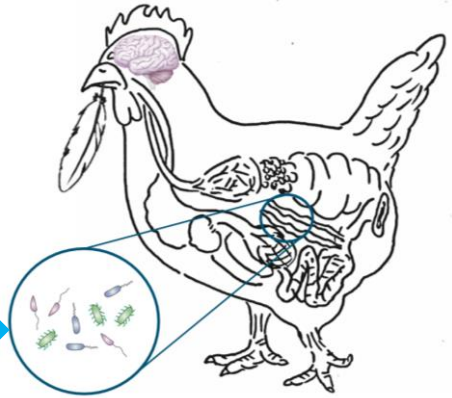
High feather pecker

Genotype

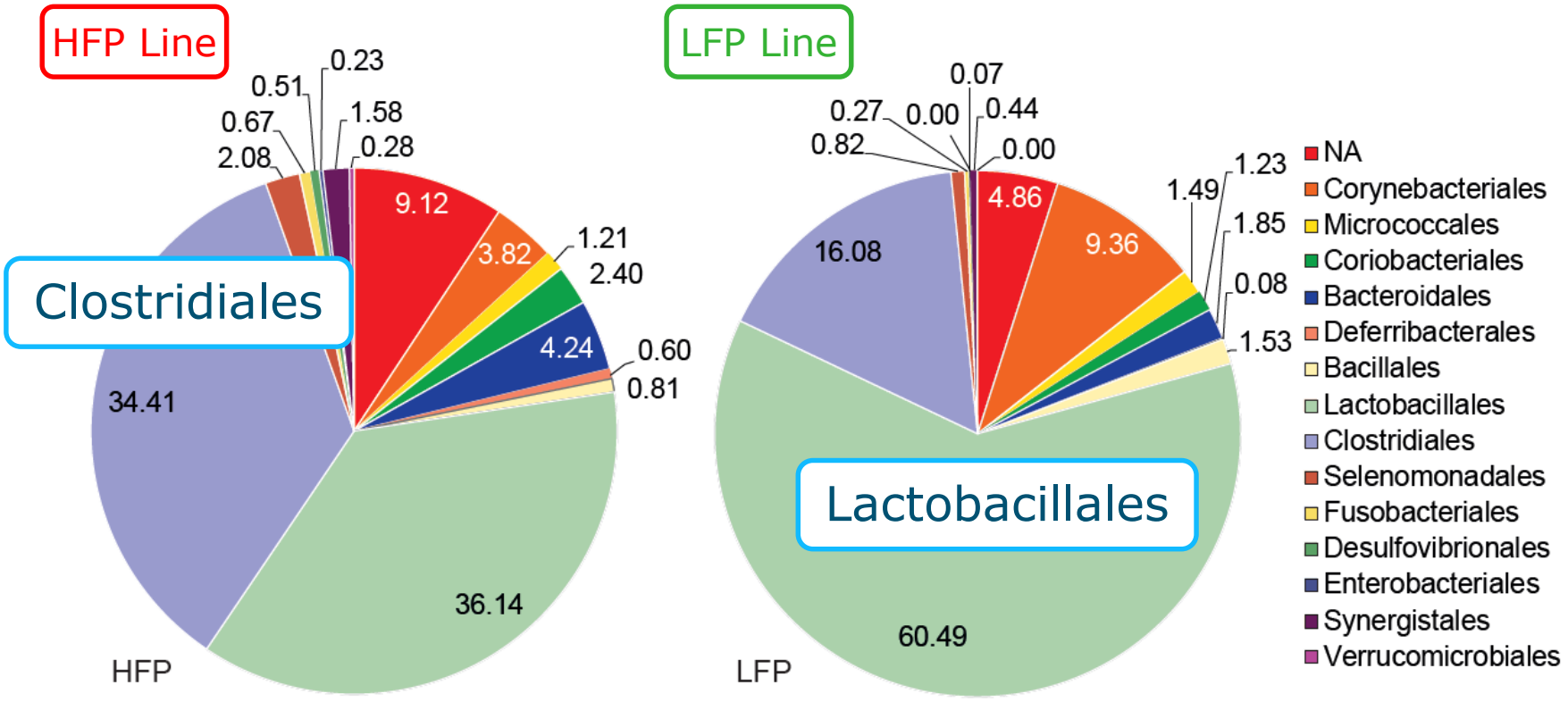
Low feather pecker

Phenotype

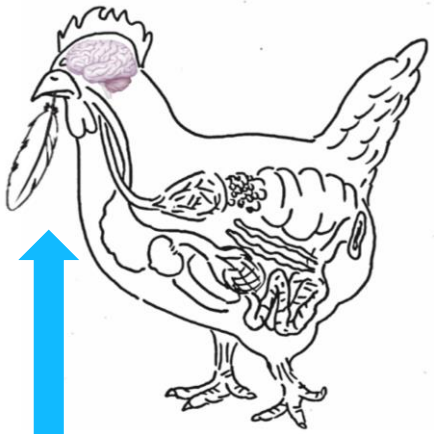
High feather pecker



Microbiota transplantation pools



Treatment



Divergently selected lines

HFP line

LFP line

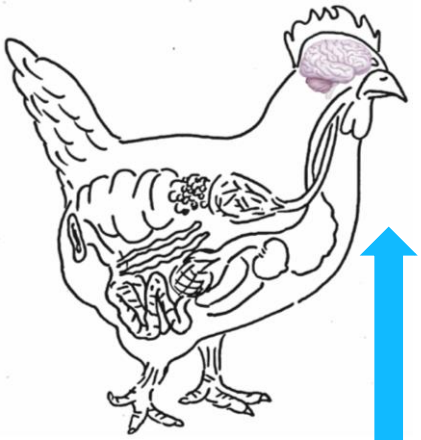
X

Treatment

HFP microbiota

LFP microbiota

Control (saline)



Timeline

Manual restraint test

3d 1w 5w 9w 13w 15w

0-1w
Treatment

During treatment (immediate effects)

HFP line

Novel object test

HFP microbiota

LFP microbiota

Novel environment test

HFP microbiota

Control

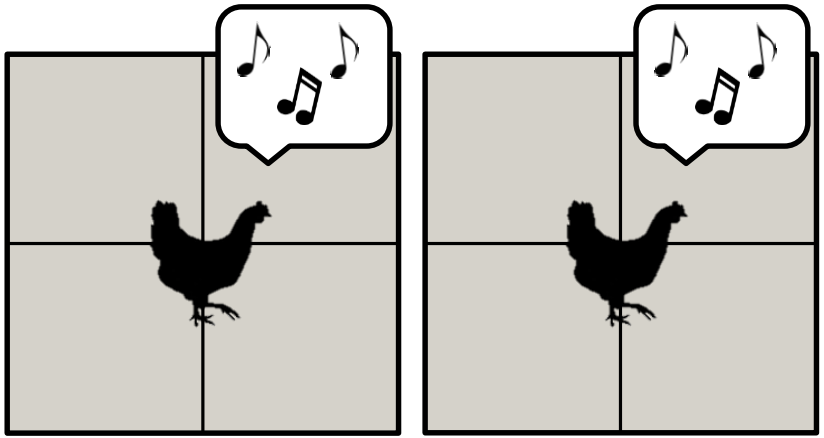
(P < 0.1)

After treatment (long-term effects)

LFP line

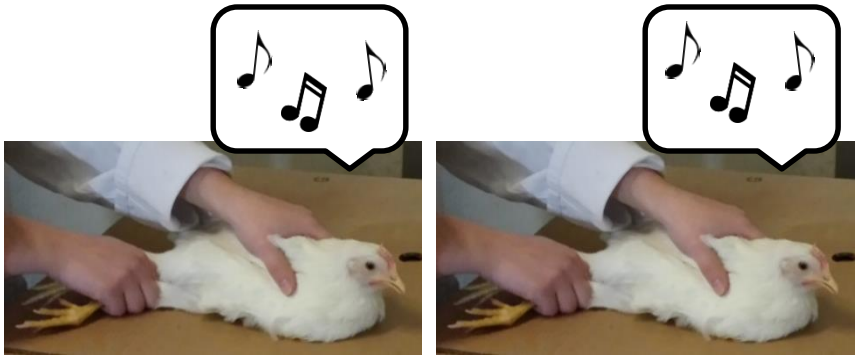
Open field test

LFP microbiota | Control



Manual restraint test

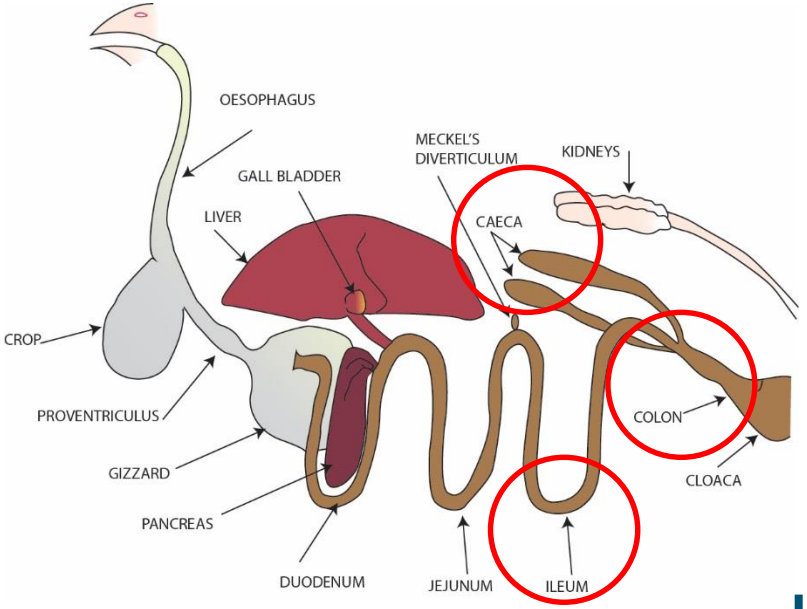
LFP microbiota | HFP microbiota | Control



(P < 0.1)

Timeline

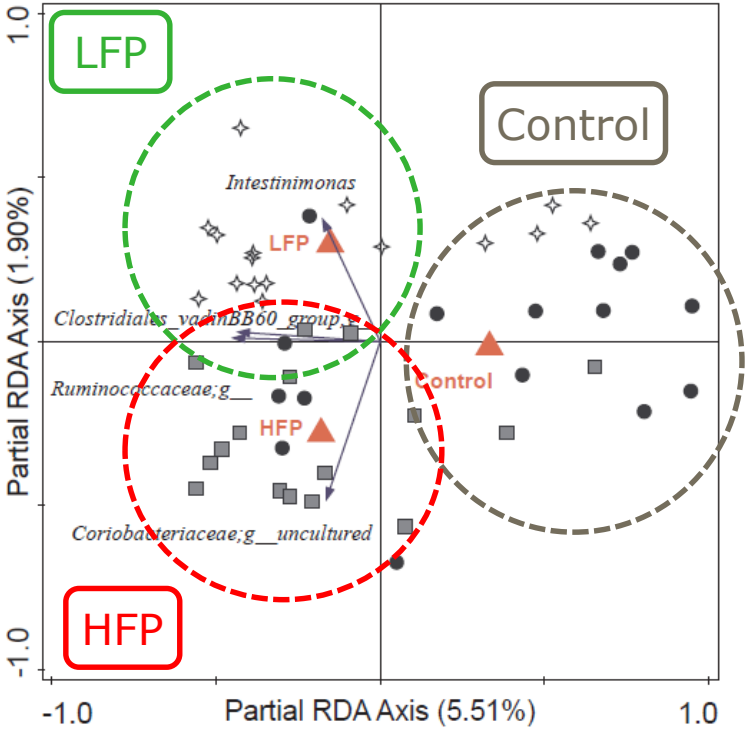
Gut content: ileum, caecum and colon



0-1w
Treatment

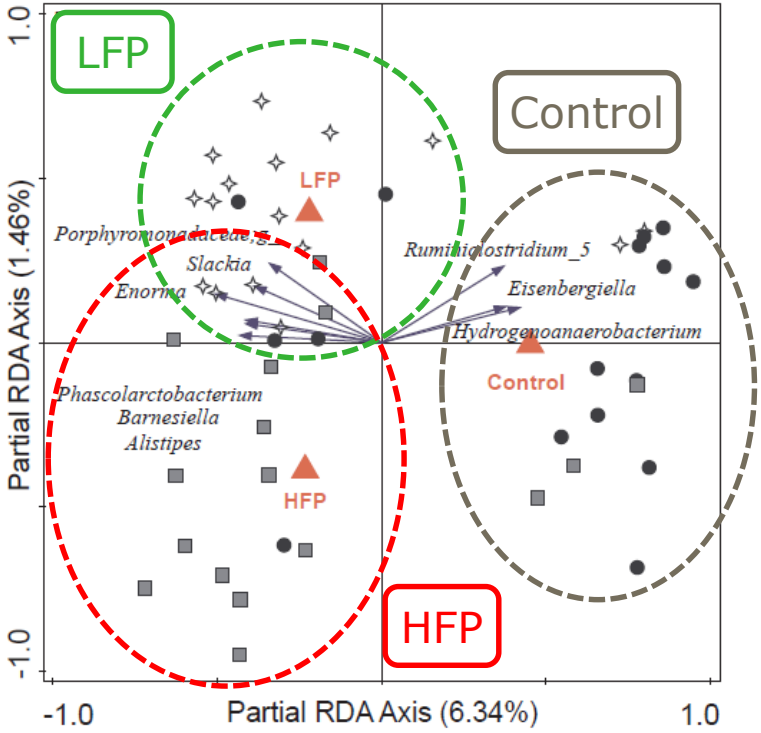
Gut microbiota composition – Caecum of HFP

5 days of age



(P < 0.05)

2 weeks of age



(P < 0.01)

Discussion

Microbiota affects brain functioning

Brain development < 2 weeks, synapse formation (Atkinson et al., 2008)

Microbiota affect brain development in rodents (Dinan and Cryan, 2017)

- Alters morphology of amygdala (regulation of anxiety and fear) (Saint-dizier et al., 2009; Luczynski et al., 2016)
- Alters expression of brain-derived neurotrophic factor (gene involved in synaptic plasticity) in amygdala (Arentsen et al., 2015)

Discussion

HFP birds more active behavioural responses (de Haas et al., 2010; Kops et al., 2017; van der Eijk et al., 2018; 2019)

<u>During treatment</u>

HFP birds adopt behaviour of donors

<u>After treatment</u>

LFP birds do not adopt behaviour of donors

Discussion

Immediate effects on behaviour in HFP line

HFP line more responsive immune system (Buitenhuis et al., 2006; van der Eijk et al., 2019)

Respond more strongly to microbiota → cytokines → alter serotonergic and dopaminergic neurotransmission (Miller et al., 2013) → alter behavioural responses

Discussion

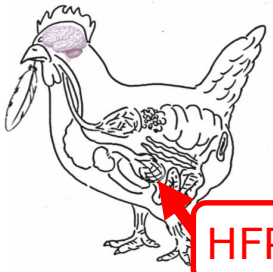
Long-term effects on behaviour in LFP line

LFP microbiota ↑ relative abundance of *Lactobacillus* (Birkl et al., 2018; van der Eijk et al., 2019)

Lactobacillus increased activity and reduced anxiety in rodents (Bravo et al., 2011; Liang et al., 2015; Liu et al., 2016)

Note: Microbiota composition did not differ between treatments in LFP line

Discussion



HFP Line

HFP microbiota

LFP Line

LFP microbiota

Homologous transplantation

Active responses (↓ fearfulness) (Forkman et al., 2007)

Feather pecking related to ↑ fearfulness

(Rodenburg et al., 2004; de Haas et al., 2014)

Note: No effects on tonic immobility duration

→ innate fearfulness (Forkman et al., 2007)

Feather pecking related to ↓ fearfulness in selection lines (Kops et al., 2017; van der Eijk et al., 2018)

Conclusion

Effects of microbiota transplantation are genotype dependent:

- Immediate effects in HFP line, birds adopt behaviour of donors
- Long-term effects in LFP line, birds do not adopt behaviour of donors

Microbiota transplantation affects behavioural responses, where homologous transplantation reduces fearfulness

Microbiota could influence the development of feather pecking

Take home messages

- Divergent selection on feather pecking affects behavioural responses and microbiota composition
- Effects of microbiota transplantation are genotype dependent
- Microbiota transplantation affects behavioural responses

Gut microbiota could influence the development of feather pecking

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