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ASSESSING BEHAVIOURAL RIGIDITY AND ITS GENETIC INFLUENCES IN AUSTRALIAN WAGYU CATTLE

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SUMMARY

Animals that can adapt well to a particular environment and exhibit beneficial behaviours have the potential to exhibit improvements in traits such as productivity and meat quality. Behavioural rigidity (BR) is defined as a lack of flexibility to an individual's approach to life meaning animals that are rigid would adapt poorly to new environments and stressors. In the current study BR was defined as the number of different feed bunks an animal visits per day, demonstrating animals that visited fewer or even exclusive feed bunks were classified as having a higher behavioural rigidity than those who visited a greater variety of feed bunks. Sex, pen, year and average daily gain all had significant correlations with BR in Wagyu cattle. This would indicate that animals that are willing to eat from multiple bunks would have a higher average daily gain and improved adaptivity to a feedlot environment. BR was heritable with an estimate of 0.17 indicating that genetic gain can be made on this trait.

INTRODUCTION

Breeding programs should consist of animals that are well adapted to a particular environment, this includes exhibiting behaviours that are associated with improved production (Adamczyk *et al.* 2013). Animals react differently to environmental stimuli, either adaptively or maladaptively which can be due to either environmental factors (how that animal has been handled in the past) or genetic variation (Haskell *et al.* 2014). These reactions to stimuli can be either positive or negative, with their response affecting metabolism and social interactions within the herd. Some studies have shown that cattle that are highly stressed or temperamental have lower meat quality or reduced weight gain when compared to other cattle in the same herd (Titterington *et al.* 2022).

Behavioural rigidity is known as lack of flexibility in a person's thoughts and approach to life. This behavioural rigidity can cause issues in a person's life as they struggle to adapt to new situations (Schultz and Searleman 2002). In cattle this behavioural rigidity could have a potential to negatively affect productivity. For example, in a feedlot situation, an animal that has high behavioural rigidity may not adapt to the new environment and have lower feed intake with resultant reduced growth. As far as the authors are aware, there has been no published research in this area.

This study aimed to measure behavioural rigidity using feed trial data collected with GrowSafe technology, investigate the effect of year, sex, growth rate and pen and identify the genetic parameters for behavioural rigidity.

MATERIALS AND METHODS

The data used was provided and collected by 3D Genetics, a Wagyu bull breeding program situated in Northern New South Wales. The data included the results of two years of feed trial data collected using the GrowSafe System (Vytelle LLC., Canada) on 3D Genetics' property "Pukawidgi". The feed trials ran for a period of approximately 50 days with adlib feeding of a corn silage based ration. In total there were 1,993 individual animal records included in the analysis, with an average pen size of 75. The average daily gain (ADG) was calculated from the results of the feed trial to give an indication of growth.

Behavioural rigidity (BR) herein was defined as the average number of bunks visited each day with a total of eight bunks in each pen. To calculate the proportion of visits, the number of visits to a specific bunk was divided by the total number of visits by the animals. For the animal to have a one-bunk preference, more than 50% of total visits needed to be to a single-bunk. For an animal to have a two-bunk preference more than 50% of total visits needed to be from one or two bunks.

A general linear model was used to calculate the potential effects of sex, year, pen and growth rate. It can be written as,

$$BR_{ijkl} = \mu + Sex_i + Pen_j + Year_k + Pen_j{:}Year_k + \beta \cdot ADG_{ijkl} + \varepsilon_{ijkl}$$

where BR_{ijkl} is behavioural rigidity, μ is the overall mean, Sex_i is fixed effect of i^{th} level of sex, Pen_j is fixed effect of j^{th} level of pen, $Year_k$ is fixed effect of k^{th} level of year, $Pen_j{:}Year_k$ is the interaction between pen and year, β is the regression coefficient of ADG_{ijkl} and ε_{ijkl} is the residual error term.

The genotype data used included 8,675 animals that were collected over many years. Seven different SNP chips were used including Illumina 777k, Illumina GGPLD V3 30K, Illumina GGPLD V4 30K, Illumina ICB 50K, Illumina GGP 100K and Weatherby's Scientific Versa50K. The common SNPs across all chips was 10 830 which were imputed up to GGPLD30K (21, 791 SNPs) using Minimac4 (Howie *et al.* 2012). All duplicated animals and SNPs with less than 1% minor allele frequency were removed. The heterozygosity fraction (Het) was calculated as the proportion of imputed heterozygote SNPs for each individual animal.

Genetic parameters were estimated through a univariate analysis using ASREML-R (Butler *et al.* 2017). The fixed effects included in the model were sex, Het and contemporary group. The contemporary group was defined as birth group, pen and feed trial date. The genomic relationship matrix was calculated using VanRanden's first method (VanRaden 2008). The variance components and heritability were estimated for behavioural rigidity.

RESULTS AND DISCUSSION

Behavioural rigidity (BR) values ranged from 1.75 to 7.92 with a mean of 6.04 and a standard deviation of 1.12. This demonstrates there was variation in the trait and phenotypically animals seemed to prefer certain bunks. Therefore, in Wagyu cattle there is some behavioural rigidity and in the feedlot environment, individual cattle show a preference for which bunk they will eat from. There was 6.71% of animals that had a one-bunk preference and 31.27% of animals that showed a two-bunk preference. There were some animals who would consume from any bunk (Figure 1a) whereas some animals preferred one or two bunks only (Figure 1b).

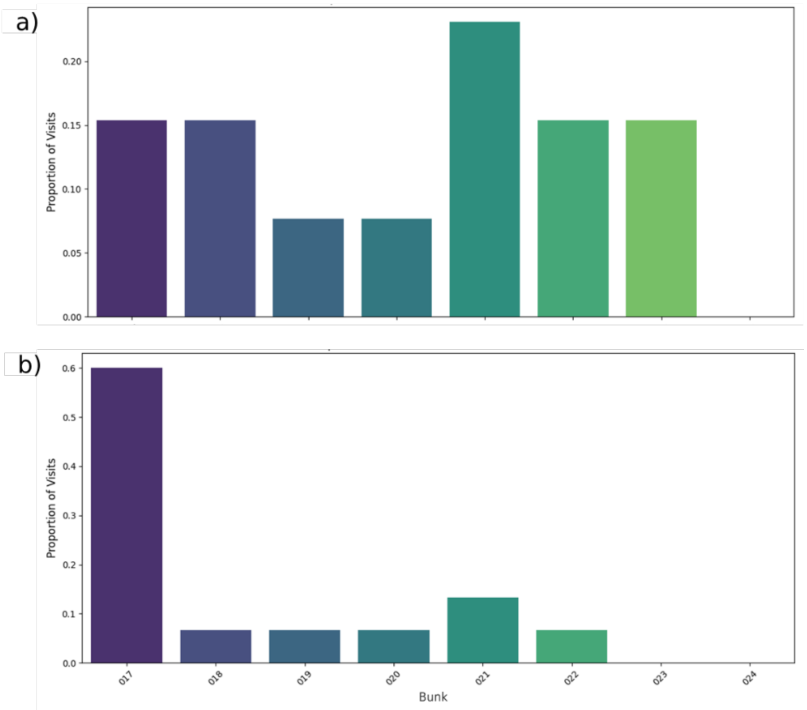

Figure 1. An example of proportion of visit to each feed bunk during a feed trial. a) had no preference of bunk, b) had a preference of majority one bunk only

BR was then included in a linear model to look at the effects of sex, pen, year and average daily gain. It was found that sex, pen, year and average daily gain were significant (Table 1). The sex had a significant impact on BR, with entire males and steers having estimates of -0.16 and -0.94 lower than females (Table 1). Feed pen also had a significant effect on BR, with feed pen 2 (FP2) having the largest effect of 1.10 above feed pen 1 (FP1; Table 1). The significant difference between feed pens would indicate that there is social hierarchy in the pen that determines what bunks animals will eat from. The interaction between pen and year was also significant with FP6:2024 had the largest difference of -1.88 below the baseline of FP1:2023. Average daily gain (ADG) also had a significant association on BR with a regression coefficient of 0.57 (Table 1). This would indicate that animals that have less BR and visit a higher number of bunks would have a higher daily gain. The interaction between ADG and BR could have an influence on the potential growth of cattle in feedlots. If the animal is only eating out of one bunk, that animal may not each as much as other animals who exhibit less behavioural rigidity and are willing to eat from any bunk.

Table 1. Coefficient estimates of linear model of behavioural rigidity with standard errors in brackets. The base values were female for sex, FP1 for pen and 2023 for year

Effect	Estimate	P-value
Mean	4.85 (0.14)	<0.001
Sex – Male	-0.16 (0.08)	0.04
Sex – Steer	-0.94 (0.11)	<0.001
Pen – FP2	1.40 (0.09)	<0.001
Pen – FP6	1.21 (0.09)	<0.001
Pen – FP7	1.21 (0.09)	<0.001
Year – 2024	0.52 (0.12)	<0.001
Average daily gain	0.57 (0.13)	<0.001
Pen – FP2:Year – 2024	-1.05 (0.16)	<0.001
Pen – FP6:Year – 2024	-1.88 (0.16)	<0.001
Pen – FP7:Year – 2024	-1.16 (0.16)	<0.001

The heritability and variance components were then estimated for BR. The heritability was 0.17 with a standard error of 0.04. Other behaviour traits in cattle have been estimated to be low-moderate (Adamczyk *et al*. 2013; Haskell *et al*. 2014; Titterington *et al*. 2022). The variance components were 0.14 for additive variance and 0.68 for residual variance. The heritability was low-moderate, demonstrating that there is a large environmental influence over the trait. One of these environmental effects could be the social hierarchy in the pen, some animals may be at the bottom of the hierarchy and only felt comfortable to eat out of certain bunks. Despite these environmental effects, there is still potential to select against BR and improve animals' ability to adapt to eat from multiple bunks in a feedlot situation.

CONCLUSION

Behavioural rigidity is known as lack of flexibility in someone's approach to life, this can cause issues as it can cause them struggle to adapt to new situations. Behavioural rigidity (BR) was defined as the average bunks visited each day over a feed trial. A general linear model found that sex, pen, year and average daily gain (ADG) were significant for BR. ADG had a significant effect of 0.57, indicating as an animal is less rigid or uses more bunks, they would have a high ADG. This could be important for animals entering the feedlot system, as an animal that shows more behavioural rigidity may exhibit lower growth rates. Further, the genetic parameters were estimated for BR with a heritability of 0.17. BR has a genetic component, and genetic gain could be achieved through selection.

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