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GENETIC AND PHENOTYPIC PARAMETERS FOR TEMPERAMENT IN WEANED LAMBS

J.E. Hocking Edwards[1,2], F.D. Brien[1,3], M.L. Hebart[1,3], G.N. Hinch[1,4], J. Hoad[1,4], K.W. Hart[1,5], G. Gaunt[1,6], M. Robertson[1,7], G. Refshauge[1,8] and T. Bird-Gardiner[1,9]

[1]Cooperative Research Centre for Sheep Industry Innovation
[2]South Australian Research Development Institute, Struan Research Centre, Naracoorte, SA, 5271
[3]South Australian Research and Development Institute, Roseworthy, SA, 5371
[4]University of New England, Armidale, NSW 2351
[5]Department of Agriculture and Food Western Australia, Narrogin, WA, 6312
[6]Department of Primary Industries, Victoria, Rutherglen, VIC, 3685
[7]Department of Primary Industries, Victoria, Hamilton, VIC, 3300
[8] Industry & Investment NSW (Primary Industries), Cowra, NSW, 2794
[9] Industry & Investment NSW (Primary Industries),, Trangie, NSW, 2823

SUMMARY

This paper reports the results from preliminary analyses of two temperament traits, flight speed and agitation, of weaned lambs from the Information Nucleus (IN) flock. Flight speed and agitation were recorded two to six weeks post weaning. The heritability (± s.e.) of flight speed was 0.07 ± 0.02 and agitation was 0.16 ± 0.03. The two traits were not phenotypically correlated (0.04 ± 0.01) and there was a low positive genetic correlation (0.21 ± 0.15) suggesting that flight speed and agitation are likely to be measuring different components of temperament.

Of the 14 potential lamb survival indicator traits recorded at birth, time taken for the lamb to follow the ewe had low positive genetic correlations with agitation. There were no phenotypic correlations between the temperament traits and lamb measurements taken at birth. It is unlikely that selection for flight speed or agitation will markedly impact early lamb behaviour traits, and it is also unlikely that there is any genetic link between temperament traits and lamb survival, although this needs to be confirmed with estimates of the maternal relationships between these traits.

INTRODUCTION

In domesticated livestock, non-threatening, routine management procedures may lead to chronic stress in livestock and can alter behaviours such as maternal ability (Fisher and Matthews 2001). Fearfulness/temperament is heritable in farm animals (reviewed by Boissy *et al.* 2005) and it may be possible to use this trait as an indirect selection criterion for hard to measure traits.

Flight speed or flight time, agitation or measurements that can be recorded during routine management activities (Starbuck *et al*. 2006; Horton *et al*. 2009) are the temperament assessment methods most likely to be useful in livestock production systems. The time taken to travel a set distance after being released from a confined space measures the escape response and is known as flight time (sec) or flight speed (m/sec). The isolation box test imposes a stress of isolation that is measured by the amount of agitation the sheep exhibits. This evaluates the animals' temperament by providing a simple measure of "calmness" or "nervousness" in sheep (Murphy 1999).

Lamb survival is a major concern in the Australian sheep industry from both an animal welfare and an economic perspective. Genetic improvement in lamb survival is slow due to low heritability of this trait (Safari *et al*. 2005). However, the use of indirect selection traits such as antenatal birth coat score, time to bleat after separation from its mother, rectal temperature and crown rump length may improve the accuracy of selection (Brien *et al*. 2010).

There is evidence from unselected lines of sheep that temperament is correlated with maternal behaviour and lamb survival in Merino ewes. There was a positive genetic correlation between litter survival and agitation ($r_g = 0.39 \pm 0.18$) but not flight time ($r_g = 0.09 \pm 0.27$) of the dam (Lennon *et al.* 2009). When temperament was assessed by measuring movement in a weigh crate, the calmest sheep exhibited better maternal behaviour and greater lamb survival (Horton *et al.* 2009).

This paper describes the heritability of flight speed and agitation of weaned lambs in addition to the genetic correlation of these temperament traits with neonatal traits that may be potential indicators of lamb survival. Preliminary analysis of indicator traits of lamb survival from the IN have been reported previously (Brien *et al.* 2010).

MATERIALS AND METHODS

The data used was from records of the 2007, 2008 and 2009 lambings of the IN. Sire and dam genotypes mated in the IN are discussed in other studies (Fogarty *et al.* 2007; Geenty *et al.* 2009).

Agitation and flight speed were undertaken on lambs two to six weeks after weaning. Agitation was measured using an isolation test. The test was conducted in a fully enclosed box (1.5 x 0.7 x 1.5 m) and the amount of movement by the lambs in 30 seconds was measured using an agitation meter (Blache and Ferguson 2005). The time it took lambs to pass between two beams of light was measured on a flight speed recorder. Flight speed (m/s) was calculated by dividing the distance between the light beams by the time taken to travel between the beams. Lamb measurements and descriptors of lamb survival have been outlined in other studies (Brien *et al.* 2009; Brien *et al.* 2010).

*Data Analysis***.** Agitation was measured on a single flock in 2007 (N=721; mean=52.0; min=0; max=164; s.d.=28.39). The numbers of lambs that had temperament traits measured in 2008 and 2009, and the raw means, ranges and standard deviations are shown in Table 1.

Table 1. Total number of animals with flight speed and agitation measurements in 2008 and 2009 and the descriptive statistics of the raw data.

	Flight speed					Agitation				
	N	mean	min	max	sd	N	mean	min	max	sd
2008	4008	1.76	0.22	7.39	0.71	4033	45.4	0	202	30.0
2009	4335	2.28	0.20	8.91	1.24	4378	50.0	0	197	30.3

Genetic Analysis. An animal model was fitted to the weaner temperament data using ASREML (Gilmour *et al.* 2009). A univariate model was fitted with flock (representing research station flock), drop (2007, 2008, 2009), lamb age (nested within flock and drop), management group (nested within flock and drop), sex, birth-rear type (11, 21, 22, 31, 32, 33), age of dam, dam breed (Merino, Border Leicester Merino), sire breed (19 different sire breeds) and all significant two-way interactions. In addition to an additive component, a maternal effect (that included both the direct maternal genetic and permanent environmental variance components) was also fitted as a random effect. To estimate phenotypic and genetic correlations, a bivariate model was fitted to the data, with the same fixed and random terms as in the univariate analysis.

RESULTS AND DISCUSSION

The heritability of flight speed was low while agitation was moderately heritable (Table 2). These results are in agreement with the heritability of flight time (0.12 ± 0.05) and agitation (0.20 ± 0.05) in unselected Merinos (Lennon *et al.* 2009). However, in sheep selected for calmness or nervousness, the heritability of agitation box score is higher (0.41; Blache and Ferguson 2005).

The phenotypic correlation between flight speed and agitation box score was 0.04 ± 0.01 and the genetic correlation was 0.21 ± 0.15. This is similar to the phenotypic correlations of 0.03 ± 0.02 and the genetic correlation of -0.26 ± 0.23 between flight time and agitation reported for the Merino Selection Demonstration Flocks (Lennon *et al.* 2009). This suggests that flight speed and agitation measure different components of temperament, therefore each measure may be associated with different production traits.

Table 2. Variances, heritabilities and standard deviation of flight speed and agitation, progeny per sire range and highest and lowest sire EBVs and accuracy.

	Flight Speed	Agitation
Additive Genetic Variance	0.033	123.1
Maternal Genetic + Environmental Variance	0.018	20.7
Phenotypic Variance	0.513	768.4
Estimated Heritability (±s.e.)	0.07 ± 0.02	0.16 ± 0.03
Phenotypic Standard Deviation	0.72	27.7
No of Sires	206	255
Number of Progeny per Sire (Min – Max)	2 - 164	1 - 167
Sire Means (Min – Max)	1.12 - 3.01	29.5 - 79.0
Sire EBV (Min – Max)	-0.34 - 0.28	-17.9 - 25.3
Accuracy (Min – Max)	0.12 - 0.85	0.20 - 0.94

In this study only the direct additive genetic correlations were estimated due to limitations in the depth of the ewe pedigree. The additive genetic correlation between lamb survival to weaning (birth weight included as a covariate) and agitation was low and negative (r_g = -0.08 ± 0.22), indicating that there is no strong relationship between sires that have lambs that survive well and sires that produce agitated offspring. In addition, flight speed was not genetically correlated with lamb survival to weaning (birth weight included as a covariate; r_g = -0.11 ± 0.28). Unfortunately the maternal effects on temperament and the maternal correlation between survival and temperament were unable to be estimated with the current dataset. However, as more data becomes available, the maternal relationship between survival and temperament may be estimated to determine whether ewes that have higher progeny survival also have calmer offspring.

Table 3. Genetic correlation coefficients (± s.e) for lamb temperament, lamb traits and maternal behaviour traits.

Trait	**Flight Speed**	**Agitation**
Birth Weight	-0.11 ± 0.13	0.06 ± 0.11
Time taken to Bleat	-0.08 ± 0.17	-0.17 ± 0.13
Visually scored lamb vigour at birth	-0.13 ± 0.14	-0.01 ± 0.11
Time taken for the lamb to contact the udder	-0.05 ± 0.20	0.21 ± 0.16
Time taken for the lamb to contact the ewe	0.02 ± 0.16	0.07 ± 0.13
Time taken for the lamb to stand	0.12 ± 0.20	0.01 ± 0.16
Time taken for the lamb to follow the ewe	0.18 ± 0.17	0.35 ± 0.13
Birth Coat Score	0.25 ± 0.13	0.12 ± 0.11
Rectal Temperature of the lamb	-0.09 ± 0.16	-0.20 ± 0.12
Thorax Circumference of the lamb	0.26 ± 0.15	0.03 ± 0.12
Metacarpal bone length of the lamb	0.02 ± 0.13	-0.02 ± 0.11
Length of the lamb from the crown to the rump	0.02 ± 0.14	0.11 ± 0.11
Maternal Behaviour Score	-0.04 ± 0.14	0.08 ± 0.11

All phenotypic correlations between temperament and maternal behaviour and lamb traits were negligible, ranging from -0.03 ± 0.02, for time to contact the udder, to 0.04 ± 0.01, for rectal temperature. Genetic correlations between weaner temperament measurements and neonatal traits were generally negligible with high errors (Table 3). Although the standard errors for estimates of heritabilities and phenotype correlations were low, indicating good precision, those for genetic correlations were much higher, so the estimates should be regarded as preliminary. Of interest, however, is that time taken for the lamb to follow the ewe was positively correlated with both agitation and flight speed, indicating that agitated weaners were slower to follow their mothers after birth.

CONCLUSION

These preliminary results suggest that flight speed and agitation are not genetically related to early lamb behaviour traits in general, with the main exception being time taken for the lamb to follow the ewe. Selection for flight speed or agitation is unlikely to impact markedly on early lamb behaviour traits, or vice versa. Our results, based on estimates of additive genetic correlations only, also suggest a lack of any genetic link between temperament traits and lamb survival, although this needs to be confirmed with estimates of the maternal relationships between these traits.

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