

Knowledge for Life

Phenotypic and Genetic Relationships Among Temperament, Immune Function, and Carcass Traits in Beef Cattle

Kerri Bates
BIF Conference
June 11, 2013

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Outline

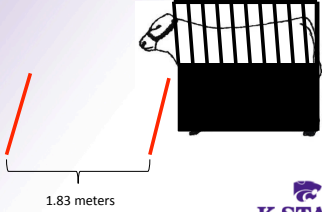
- Introduction
- Project
 - Phenotypic Analysis
 - Materials and Methods
 - Results and Discussion
 - Conclusions
 - Genetic Analysis
 - Materials and Methods
 - Results and Discussion
 - Conclusions
- Questions

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Exit Velocity

- Burrow et al., 1988
- Measured in m/s
- More temperamental cattle = greater exit velocity (EV)
- Calmer cattle = lower EV



1.83 meters

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Chute Score

- Appraised while animal is in the chute
- Scores (Grandin, 1993; BIF Guidelines, 2002):
 - 1=Docile.
 - 2=Restless.
 - 3=Nervous.
 - 4=Flighty (Wild).
 - 5=Aggressive.
 - 6=Very Aggressive.

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Cortisol

- Glucocorticoid
- Secreted after the HPA axis is activated
- Indicative of short term stress (Grandin, 1997)
 - Elevated as a response to:
 - Restraint
 - Processing
 - Novel environments
- Inhibits cell-mediated immune response

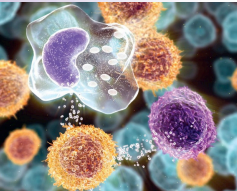
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Interleukin-8

- Cytokine
- Neutrophil Chemoattractant
- Puts the "X" on the bacterial target



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Bovine Respiratory Disease

Stress Factors	Viral Agents	Bacteria
Heat	PI3	Pasteurella
Cold	IBR	Hemophilus
Dust	BVD	Other
Dampness	BRSV	
Injury	Adenovirus	
Fatigue	Rhinovirus	
Dehydration	Herpesvirus IV	
Hunger	Enterovirus	
Anxiety	MCF	
Irritant Gases	Reovirus	
Nutritional Deficiencies		
Surgery		

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Materials and Methods

— Animals

- Crossbred steers from single ranch source
 - 2007 (Year 1; n=1,551)
 - 2008 (Year 2; n=1,319)
- Shipped from Nebraska to a commercial feedlot in southeastern Colorado
- Processed within two days of placement each year



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Materials and Methods

— Processing

- Feedlot placement (d 0):
 - Year 1: RFID, weights, blood sample, ear notch, ultrasound measures, oral + pour-on parasiticide, and a growth promotant
 - Year 2: Same measures with the addition of vaccinations
 - » Pyramid 2 + Type II BVD
 - » Presponse SQ
- Reimplantation (d ~ 74): Weight, ultrasound measures
- ~ d 140: Weight and ultrasound measures

— Temperament measures

- Chute score (CS)
- Exit Velocity (EV)

} Appraised at placement and reimplantation

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
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
— Harvest (d ~ 225)

- Hot Carcass Weight
- Yield Grade
- Quality Grade
- Marbling score
- Ribeye area
- Lung score
 - 0= healthy lung, no unhealed lesions
 - 1= <5% lung damage, minimal adhesions
 - 2= ~ 1 anterior ventral lobe damage
 - 3= >15% lung damage


Healthy Lungs



Effects of Pneumonia



Irreversible Lung Damage



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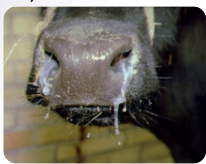
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Materials and Methods

— Bovine Respiratory Disease (BRD) treatment

- Signs:
 - Lethargy
 - Nasal and ocular discharge
 - Depression
 - Cough
 - Rectal temperatures > 103.5° F
- Remained at treatment center for 5-7 days



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Materials and Methods

— Metabolite and cytokine assays

- Cortisol: Coat-A-Count radioimmunoassay
- Interleukin 8 (IL-8): ELISA kit
 - Shuster et al., 1996; 1997

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Materials and Methods

- Datasets
 - Year 1
 - Year 2
 - Combined
- Statistical analysis in SAS
 - General linear model
 - Multivariate analysis of variance
 - Logistic regression procedure
- Fixed effects:
 - Pre-feedlot BRD treatment
 - Contemporary group

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Results

Least squares means for all traits collected at **feedlot placement** for cattle that were treated and not treated for BRD pre-weaning and those that were treated and not treated for BRD in the feedlot

Trait	Pre-feedlot BRD treatment			Feedlot BRD treatment		
	Treated (n = 306)	Not Treated (n = 2564)	P-Value	Treated (n = 808)	Not Treated (n = 2062)	P-Value
IL-8 (pg/mL)	477.75	458.15	0.328	477.69	458.20	0.117
Cortisol (ng/mL)	33.09	36.04	0.007	35.43	33.69	0.011
CS	2.73	2.84	0.078	2.85	2.72	0.001
EV (m/s)	2.95	2.99	0.427	2.98	2.95	0.458
Weight (kg)	223.18	221.79	0.489	222.12	222.86	0.549

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Results

Least squares means for all traits collected at **reimplantation** for cattle that were treated and not treated for BRD pre-weaning and those that were treated and not treated for BRD in the feedlot

Trait	Pre-feedlot BRD treatment			Feedlot BRD treatment		
	Treated (n = 306)	Not Treated (n = 2564)	P-Value	Treated (n = 808)	Not Treated (n = 2062)	P-Value
CS	2.46	2.45	0.907	2.27	2.64	<0.0001
EV (m/s)	3.06	3.00	0.365	3.07	3.00	0.141
Weight (kg)	357.69	355.61	0.472	351.26	362.04	<0.0001
Gain1 (kg)	133.81	133.69	0.958	128.98	138.53	<0.0001

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Results

Least squares means for all traits collected at the **third processing** for cattle that were treated and not treated for BRD pre-weaning and those that were treated and not treated for BRD in the feedlot

Trait	Pre-feedlot BRD treatment			BRD treatment in feedlot		
	Treated (n = 306)	Not Treated (n = 2564)	P-Value	Treated (n = 808)	Not Treated (n = 2062)	P-Value
Weight (kg)	461.39	460.34	0.786	454.87	466.85	<0.0001
Gain2 (kg)	104.70	105.04	0.869	104.46	105.28	0.536
Total Gain (kg)	239.54	239.25	0.919	234.76	244.03	<0.0001

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Results

Odds ratio estimates with associated 95% confidence intervals and p-values for disease and performance variables related to pre- and post-entry treatment.

Pre-feedlot BRD treatment			
Trait	Odds Ratio Estimate	95% Confidence Interval	P-Value
Feedlot BRD Treatment	1.056	(0.722, 1.542)	0.7796
Mortality	0.202	(0.455, 2.219)	0.9901

Feedlot BRD Treatment			
Trait	Odds Ratio Estimate	95% Confidence Interval	P-Value
Mortality	4.517	(2.931, 6.961)	<0.0001

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Results

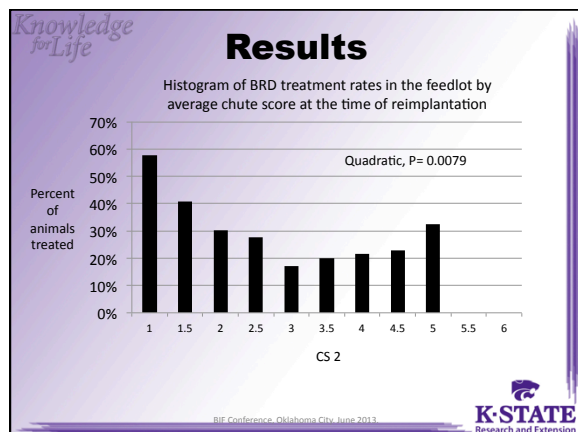
Odds ratio estimates with associated 95% confidence interval and P values for metabolic and temperament factors associated with BRD treatment in the feedlot

Feedlot BRD Treatment			
Trait	Odds Ratio Estimate	95% Confidence Interval	P-Value
EV1	1.088	(0.961, 1.231)	0.183
EV2	1.166	(1.055, 1.289)	0.003
CS1	0.990	(0.882, 1.111)	0.861
CS2	1.688	(1.501, 1.898)	<0.0001
IL-8	1.000	(0.999, 1.000)	0.1466
CORTISOL	0.993	(0.986, 1.000)	0.0541

Least squares means of the chute score suggested that lower chute scores at re-implant are the cattle that were treated in the feedlot... Why?

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Results

Odds ratio estimates with associated 95% confidence intervals and P-values for metabolic and temperament factors associated with USDA Quality Grade

QUALITY GRADE			
Trait	Odds Ratio Estimate	95% Confidence Interval	P-Value
EV1	0.976	(0.873, 1.090)	0.663
EV2	0.964	(0.880, 1.055)	0.428
CS1	1.042	(0.936, 1.160)	0.456
CS2	0.984	(0.888, 1.090)	0.753
IL-8	1.000	(0.999, 1.000)	0.268
CORTISOL	1.006	(1.000, 1.012)	0.056

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Results

Odds ratio estimates with associated 95% confidence intervals and P-values for metabolic and temperament factors associated with feedlot steer mortality

MORTALITY			
Trait	Odds Ratio Estimate	95% Confidence Interval	P-Value
EV1	1.107	(0.870, 1.409)	0.409
EV2	0.978	(0.784, 1.220)	0.841
CS1	1.176	(0.936, 1.477)	0.163
CS2	0.901	(0.698, 1.163)	0.422
IL-8	1.001	(1.000, 1.001)	0.150
CORTISOL	1.005	(0.990, 1.019)	0.525

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Results

Partial correlation coefficients between measures of temperament at the first and second processing

Trait	CS 1	CS 2	EV 1	EV 2
CS 1	1.000			
CS 2	0.2351***	1.000		
EV 1	0.1406***	0.1803***	1.000	
EV 2	0.1373***	0.2223***	0.4448***	1.000

* $P < 0.05$; ** $P < 0.01$; and *** $P < 0.001$

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Results

Partial correlation coefficients between temperament measures and blood parameters, performance traits, and carcass traits

Trait	CS 1	CS 2	EV 1	EV 2
Cortisol	0.0720***	0.0754**	0.0372	0.1120***
IL-8	-0.0110	-0.0257	0.0157	0.0437
WT 1	0.0255	0.0134	-0.0084	-0.0262
WT 2	-0.0115	-0.0123	-0.0447	-0.1049***
WT 3	-0.0233	-0.0404	-0.0588*	-0.1113
Gain1	-0.0335	-0.0253	-0.0480	-0.1080***
Gain2	-0.0221	-0.0492*	-0.0336	-0.0344
Total Gain	-0.0449	-0.0575*	-0.0656*	-0.1174***
HCW	0.0185	-0.0236	-0.0371	-0.0799***
YG	-0.0280	-0.0378	-0.0147	-0.0718**
MS	-0.0643**	-0.0141	-0.0178	-0.0445
REA	0.0226	0.0093	-0.0088	0.0125
LUNG	0.0375	0.0040	-0.0090	-0.0111

* $P < 0.05$; ** $P < 0.01$; and *** $P < 0.001$

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Results

	CS2										Total
CS1	1	1.5	2	2.5	3	3.5	4	4.5	5	6	
1	11	4	30	6	9	2	3	0	0	0	65
1.5	12	6	61	16	35	4	3	1	0	0	138
2	40	37	256	47	143	27	29	0	1	0	580
2.5	23	21	188	55	130	25	15	2	2	0	461
3	47	31	297	116	259	58	53	4	5	1	871
3.5	14	10	93	26	89	20	28	4	6	0	290
4	18	14	83	27	88	25	35	5	11	0	306
4.5	3	5	17	7	13	7	14	6	7	0	79
5	2	1	0	2	3	1	6	0	2	0	17
Total	170	129	1025	302	769	169	186	22	34	1	2807

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Conclusions

- Cattle that were treated for BRD in the feedlot entered with greater stress levels and temperaments
- Those treated for BRD had reduced gains and weights and had an increased odds of mortality
- Easily excitable cattle had lower HCW, YG, MS, and REA

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Genetic Analysis

- **Heritabilities**
 - Cortisol
 - IL-8
 - Chute score
 - Exit velocity
 - Change in chute score
 - Change in exit velocity
 - Lung lesions
 - BRD incidence
 - REA
 - YG
 - HCW
 - MS
- **Genetic correlations**
- **Repeatabilities**
 - Exit velocity
 - Chute score

Ability to acclimate

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Genetic Analysis

- Animals
 - Combined dataset
- Statistical Analysis
 - ASREML
 - Two trait animal mixed model
 - Random effect: Additive genetics (and PE for repeatabilities)
 - Fixed effects: contemporary group and pre-weaning BRD treatment
 - 2,870 animal records
 - Pedigree file had 7,177 animals with up to 7 generations of pedigree
 - Probit function for analyses that included BRD treatment incidence

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Statistical Models

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} X_1 & 0 \\ 0 & X_2 \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \begin{bmatrix} Z_1 & 0 \\ 0 & Z_2 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}$$

y = vector of phenotypic observations
X = incidence matrix of fixed effects
b = vector of fixed effects solutions
Z = incidence matrix of random effects
u = vector of random effects solutions
e = vector of residual effects

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HERITABILITY

“A measure of the strength of the relationship between breeding values and phenotypic values for a trait in a population.”-R. Bourdon, *Understanding Animal Breeding*

$$h^2 = \frac{\sigma_a^2}{\sigma_p^2}$$

$h^2 < 0.20$ = “Lowly heritable”
 $0.20 \leq h^2 < 0.40$ = “Moderately heritable”
 $h^2 \geq 0.40$ = “Highly heritable”

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Heritabilities

Trait	Heritability	IL-8	CS1	CS2	EV1	EV2	HCW	MS	REA	YG	LUNG	BRD
Cortisol	0.23 (0.06)	0.01 (0.16)	0.07 (0.17)	0.09 (0.19)	-0.11 (0.19)	0.11 (0.16)	0.26 (0.06)	0.22 (0.14)	0.38 (0.14)	-0.20 (0.30)	0.58 (0.22)	
IL-8	0.34 (0.07)	0.15 (0.15)	-0.08 (0.17)	-0.31 (0.17)	-0.22 (0.15)	0.62 (0.13)	0.49 (0.25)	0.20 (0.25)	0.03 (0.18)	0.05 (0.23)		
CS1	0.23 (0.05)	0.19 (0.17)	0.31 (0.17)	-0.02 (0.17)	0.39 (0.07)	0.24 (0.06)	0.11 (0.11)	0.32 (0.23)	0.08 (0.20)	0.31 (0.31)		
CS2	0.19 (0.05)	0.27 (0.19)	0.27 (0.17)	0.17 (0.05)	0.27 (0.11)	0.27 (0.09)	0.06 (0.05)	0.12 (0.03)	0.08 (0.08)	0.12 (0.03)		
EV1												
EV2												

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Heritabilities

Cortisol	IL-8	CS1	CS2	EV1	EV2	Change in EV	Change in CS
0.23	0.34	0.23	0.19	0.17	0.27	0.11	0.10

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Heritabilities

Cortisol	IL-8	CS1	CS2	EV1	EV2	Change in EV	Change in CS
0.23	0.34	0.23	0.19	0.17	0.27	0.11	0.10

- Stricklin et al., 1980 = 0.44
- Burrow and Corbet, 2000 = 0.30
- Kadel et al., 2006 = 0.15

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Heritabilities

Cortisol	IL-8	CS1	CS2	EV1	EV2	Change in EV	Change in CS
0.23	0.34	0.23	0.19	0.17	0.27	0.11	0.10

- Burrow and Corbet, 2000 = 0.35
- Burrow et al., 2001 = 0.40
- Kadel et al., 2006 = 0.21
- Nkrumah et al., 2007 = 0.49
- Weaber and Creason, 2007 = 0.35
- Rolfe et al., 2011 = 0.34
- Sant'Anna et al., 2012 = 0.26

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Heritabilities

Cortisol	IL-8	CS1	CS2	EV1	EV2	Change in EV	Change in CS
0.23	0.34	0.23	0.19	0.17	0.27	0.11	0.10

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Heritabilities

Lung	BRD	HCW	MS	REA	YG
0.06	0.12	0.26	0.62	0.24	0.39

- Muggli-Cockett et al., 1990
 - 0.10 pre-weaning
 - 0.06 post-weaning
- Snowden et al., 2005 = 0.10
- Snowden et al., 2006 = 0.08
- Snowden et al., 2007 = 0.08
- Heringstad et al., 2008 = 0.05
- Schneider et al., 2008 = 0.07

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Heritabilities

Lung	BRD	HCW	MS	REA	YG
0.06	0.12	0.26	0.62	0.24	0.39

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Genetic Correlations

Correlation between breeding values (or additive genetics) for the two traits

$$r_{a_{1,2}} = \frac{\sigma_{a_{1,2}}}{\sigma_{a_1} * \sigma_{a_2}}$$

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Genetic Correlations

Trait	Cortisol	IL-8	CS1	CS2	EV1	EV2
Cortisol	0.23 (0.06)	-0.01 (0.16)	0.07 (0.17)	0.09 (0.19)	-0.11 (0.19)	0.11 (0.16)
IL-8		0.34 (0.07)	-0.04 (0.15)	-0.08 (0.17)	-0.31 (0.17)	-0.22 (0.15)
CS1			0.23 (0.05)	0.37 (0.17)	0.31 (0.17)	-0.02 (0.17)
CS2				0.19 (0.05)	0.23 (0.19)	0.27 (0.17)
EV1					0.17 (0.05)	0.73 (0.11)
EV2						0.27 (0.06)

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Genetic Correlations

Trait	Cortisol	IL-8	CS1	CS2	EV1	EV2
Cortisol	0.23 (0.06)	-0.01 (0.16)	0.07 (0.17)	0.09 (0.19)	-0.11 (0.19)	0.11 (0.16)
IL-8		0.34 (0.07)	-0.04 (0.15)	-0.08 (0.17)	-0.31 (0.17)	-0.22 (0.15)
CS1			0.23 (0.05)	0.37 (0.17)	0.31 (0.17)	-0.02 (0.17)
CS2				0.19 (0.05)	0.23 (0.19)	0.27 (0.17)
EV1					0.17 (0.05)	0.73 (0.11)
EV2						0.27 (0.06)

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Genetic Correlations

Trait	Gain1	Gain2	Total Gain	HCW	MS	REA	YG	LUNG	BRD
Cortisol	0.03 (0.16)	-0.19 (0.21)	-0.14 (0.18)	-0.34 (0.17)	-0.06 (0.14)	-0.19 (0.18)	0.08 (0.16)	0.16 (0.31)	-0.68 (0.22)
IL-8	0.04 (0.14)	0.19 (0.20)	0.18 (0.15)	0.40 (0.15)	0.35 (0.11)	-0.01 (0.16)	0.37 (0.14)	-0.44 (0.32)	0.35 (0.20)
CS1	-0.16 (0.16)	0.00 (0.21)	-0.14 (0.17)	0.18 (0.17)	-0.01 (0.13)	0.39 (0.18)	-0.21 (0.16)	-0.23 (0.33)	-0.01 (0.22)
CS2	-0.04 (0.18)	0.28 (0.22)	0.12 (0.19)	0.05 (0.20)	-0.16 (0.15)	0.28 (0.20)	-0.30 (0.17)	-0.28 (0.35)	-0.60 (0.22)
EV1	-0.23 (0.17)	0.09 (0.23)	-0.14 (0.19)	-0.12 (0.19)	-0.01 (0.15)	0.43 (0.19)	-0.46 (0.16)	0.36 (0.34)	-0.09 (0.24)
EV2	-0.30 (0.15)	0.36 (0.20)	-0.08 (0.16)	-0.24 (0.17)	-0.14 (0.13)	0.17 (0.17)	-0.29 (0.14)	0.16 (0.29)	-0.34 (0.21)

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Genetic Correlations

Trait	Gain1	Gain2	Total Gain	HCW	MS	REA	YG	LUNG	BRD
Cortisol	0.03 (0.16)	-0.19 (0.21)	-0.14 (0.18)	-0.34 (0.17)	-0.06 (0.14)	-0.19 (0.18)	0.08 (0.16)	0.16 (0.31)	-0.68 (0.22)
IL-8	0.04 (0.14)	0.19 (0.20)	0.18 (0.15)	0.40 (0.15)	0.35 (0.11)	-0.01 (0.16)	0.37 (0.14)	-0.44 (0.32)	0.35 (0.20)
CS1	-0.16 (0.16)	0.00 (0.21)	-0.14 (0.17)	0.18 (0.17)	-0.01 (0.13)	0.39 (0.18)	-0.21 (0.16)	-0.23 (0.33)	-0.01 (0.22)
CS2	-0.04 (0.18)	0.28 (0.22)	0.12 (0.19)	0.05 (0.20)	-0.16 (0.15)	0.28 (0.20)	-0.30 (0.17)	-0.28 (0.35)	-0.60 (0.22)
EV1	-0.23 (0.17)	0.09 (0.23)	-0.14 (0.19)	-0.12 (0.19)	-0.01 (0.15)	0.43 (0.19)	-0.46 (0.16)	0.36 (0.34)	-0.09 (0.24)
EV2	-0.30 (0.15)	0.36 (0.20)	-0.08 (0.16)	-0.24 (0.17)	-0.14 (0.13)	0.17 (0.17)	-0.29 (0.14)	0.16 (0.29)	-0.34 (0.21)

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Genetic Correlations

Trait	Gain1	Gain2	Total Gain	HCW	MS	REA	YG	LUNG	BRD
Cortisol	0.03 (0.16)	-0.19 (0.21)	-0.14 (0.18)	-0.34 (0.17)	-0.06 (0.14)	-0.19 (0.18)	0.08 (0.16)	0.16 (0.31)	-0.68 (0.22)
IL-8	0.04 (0.14)	0.19 (0.20)	0.18 (0.15)	0.40 (0.15)	0.35 (0.11)	-0.01 (0.16)	0.37 (0.14)	-0.44 (0.32)	0.35 (0.20)
CS1	-0.16 (0.16)	0.00 (0.21)	-0.14 (0.17)	0.18 (0.17)	-0.01 (0.13)	0.39 (0.18)	-0.21 (0.16)	-0.23 (0.33)	-0.01 (0.22)
CS2	-0.04 (0.18)	0.28 (0.22)	0.12 (0.19)	0.05 (0.20)	-0.16 (0.15)	0.28 (0.20)	-0.30 (0.17)	-0.28 (0.35)	-0.60 (0.22)
EV1	-0.23 (0.17)	0.09 (0.23)	-0.14 (0.19)	-0.12 (0.19)	-0.01 (0.15)	0.43 (0.19)	-0.46 (0.16)	0.36 (0.34)	-0.09 (0.24)
EV2	-0.30 (0.15)	0.36 (0.20)	-0.08 (0.16)	-0.24 (0.17)	-0.14 (0.13)	0.17 (0.17)	-0.29 (0.14)	0.16 (0.29)	-0.34 (0.21)

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Genetic Correlations

Trait	Gain1	Gain2	Total Gain	HCW	MS	REA	YG	LUNG	BRD
Cortisol	0.03 (0.16)	-0.19 (0.21)	-0.14 (0.18)	-0.34 (0.17)	-0.06 (0.14)	-0.19 (0.18)	0.08 (0.16)	0.16 (0.31)	-0.68 (0.22)
IL-8	0.04 (0.14)	0.19 (0.20)	0.18 (0.15)	0.40 (0.15)	0.35 (0.11)	-0.01 (0.16)	0.37 (0.14)	-0.44 (0.32)	0.35 (0.20)
CS1	-0.16 (0.16)	0.00 (0.21)	-0.14 (0.17)	0.18 (0.17)	-0.01 (0.13)	0.39 (0.18)	-0.21 (0.16)	-0.23 (0.33)	-0.01 (0.22)
CS2	-0.04 (0.18)	0.28 (0.22)	0.12 (0.19)	0.05 (0.20)	-0.16 (0.15)	0.28 (0.20)	-0.30 (0.17)	-0.28 (0.35)	-0.60 (0.22)
EV1	-0.23 (0.17)	0.09 (0.23)	-0.14 (0.19)	-0.12 (0.19)	-0.01 (0.15)	0.43 (0.19)	-0.46 (0.16)	0.36 (0.34)	-0.09 (0.24)
EV2	-0.30 (0.15)	0.36 (0.20)	-0.08 (0.16)	-0.24 (0.17)	-0.14 (0.13)	0.17 (0.17)	-0.29 (0.14)	0.16 (0.29)	-0.34 (0.21)

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Genetic Correlations

Trait	Gain1	Gain2	Total Gain	HCW	MS	REA	YG	LUNG	BRD
Cortisol	0.03 (0.16)	-0.19 (0.21)	-0.14 (0.18)	-0.34 (0.17)	-0.06 (0.14)	-0.19 (0.18)	0.08 (0.16)	0.16 (0.31)	-0.68 (0.22)
IL-8	0.04 (0.14)	0.19 (0.20)	0.18 (0.15)	0.40 (0.15)	0.35 (0.11)	-0.01 (0.16)	0.37 (0.14)	-0.44 (0.32)	0.35 (0.20)
CS1	-0.16 (0.16)	0.00 (0.21)	-0.14 (0.17)	0.18 (0.17)	-0.01 (0.13)	0.39 (0.18)	-0.21 (0.16)	-0.23 (0.33)	-0.01 (0.22)
CS2	-0.04 (0.18)	0.28 (0.22)	0.12 (0.19)	0.05 (0.20)	-0.16 (0.15)	0.28 (0.20)	-0.30 (0.17)	-0.28 (0.35)	-0.60 (0.22)
EV1	-0.23 (0.17)	0.09 (0.23)	-0.14 (0.19)	-0.12 (0.19)	-0.01 (0.15)	0.43 (0.19)	-0.46 (0.16)	0.36 (0.34)	-0.09 (0.24)
EV2	-0.30 (0.15)	0.36 (0.20)	-0.08 (0.16)	-0.24 (0.17)	-0.14 (0.13)	0.17 (0.17)	-0.29 (0.14)	0.16 (0.29)	-0.34 (0.21)

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Genetic Correlations

Trait	Gain1	Gain2	Total Gain	HCW	MS	REA	YG	LUNG	BRD
Cortisol	0.03 (0.16)	-0.19 (0.21)	-0.14 (0.18)	-0.34 (0.17)	-0.06 (0.14)	-0.19 (0.18)	0.08 (0.16)	0.16 (0.31)	-0.68 (0.22)
IL-8	0.04 (0.14)	0.19 (0.20)	0.18 (0.15)	0.40 (0.15)	0.35 (0.11)	-0.01 (0.16)	0.37 (0.14)	-0.44 (0.32)	0.35 (0.20)
CS1	-0.16 (0.16)	0.00 (0.21)	-0.14 (0.17)	0.18 (0.17)	-0.01 (0.13)	0.39 (0.18)	-0.21 (0.16)	-0.23 (0.33)	-0.01 (0.22)
CS2	-0.04 (0.18)	0.28 (0.22)	0.12 (0.19)	0.05 (0.20)	-0.16 (0.15)	0.28 (0.20)	-0.30 (0.17)	-0.28 (0.35)	-0.60 (0.22)
EV1	-0.23 (0.17)	0.09 (0.23)	-0.14 (0.19)	-0.12 (0.19)	-0.01 (0.15)	0.43 (0.19)	-0.46 (0.16)	0.36 (0.34)	-0.09 (0.24)
EV2	-0.30 (0.15)	0.36 (0.20)	-0.08 (0.16)	-0.24 (0.17)	-0.14 (0.13)	0.17 (0.17)	-0.29 (0.14)	0.16 (0.29)	-0.34 (0.21)

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Genetic Correlations

TRAIT	HCW	MS	REA	YG	LUNG	BRD
HCW	0.26 (0.06)	0.05 (0.14)	0.22 (0.18)	0.38 (0.14)	-0.20 (0.30)	0.58 (0.22)
MS		0.62 (0.08)	-0.46 (0.13)	0.49 (0.10)	0.20 (0.25)	0.03 (0.18)
REA			0.24 (0.06)	-0.03 (0.11)	-0.30 (0.32)	0.05 (0.23)
YG				0.39 (0.07)	0.36 (0.31)	0.08 (0.20)
LUNG					0.06 (0.05)	-0.35 (0.39)
BRD						0.12 (0.03)

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Genetic Correlations

TRAIT	HCW	MS	REA	YG	LUNG	BRD
HCW	0.26 (0.06)	0.05 (0.14)	0.22 (0.18)	0.38 (0.14)	-0.20 (0.30)	0.58 (0.22)
MS		0.62 (0.08)	-0.46 (0.13)	0.49 (0.10)	0.20 (0.25)	0.03 (0.18)
REA			0.24 (0.06)	-0.03 (0.11)	-0.30 (0.32)	0.05 (0.23)
YG				0.39 (0.07)	0.36 (0.31)	0.08 (0.20)
LUNG					0.06 (0.05)	-0.35 (0.39)
BRD						0.12 (0.03)

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Repeatabilities

Measures the strength of the relationship between the first record and future records of a trait that can be measured repeatedly on a single animal

$$r = \frac{\sigma_{PA}^2}{\sigma_P^2}$$

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Repeatabilities

Temperament Measure	Repeatability (\pm SE)
Chute score	0.17 ± 0.02
Exit velocity	0.41 ± 0.02

- Flight Time Repeatability:
 - Kadel et al., 2000 = 0.46
- Repeatability of CS:
 - Hearnshaw and Morris, 1984 = 0.43
- Repeatability of EV:
 - Rolfe et al., 2011 = 0.63

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Conclusions

- Cattle with genetics for a calmer temperament will be more genetically predisposed to BRD
- Cattle with genetics to be more temperamental will have genetics for greater REA, reduced MS, and reduced YG
- Measures of temperament and immune function are lowly to moderately heritable
- EV is a more repeatable measure of temperament than CS

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- Zoetis and all collaborators
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Thank you!

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