Canine Performance Sciences

Advancing the Mobile Sensor Technology

Building a Better Detection Dog

AUBURN UNIVERSITY

COLLEGE OF VETERINARY MEDICINE

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Canine Performance Sciences

Presentation Overview

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- What is the *Canine Performance Sciences* (CPS)Program
- Why purpose breeding & raising of detector dogs is needed?
- Structure and function of CPS detector dog production activities
- CPS research & development in detector dog production
- Lessons learned in nearly 20 years of detector dog production

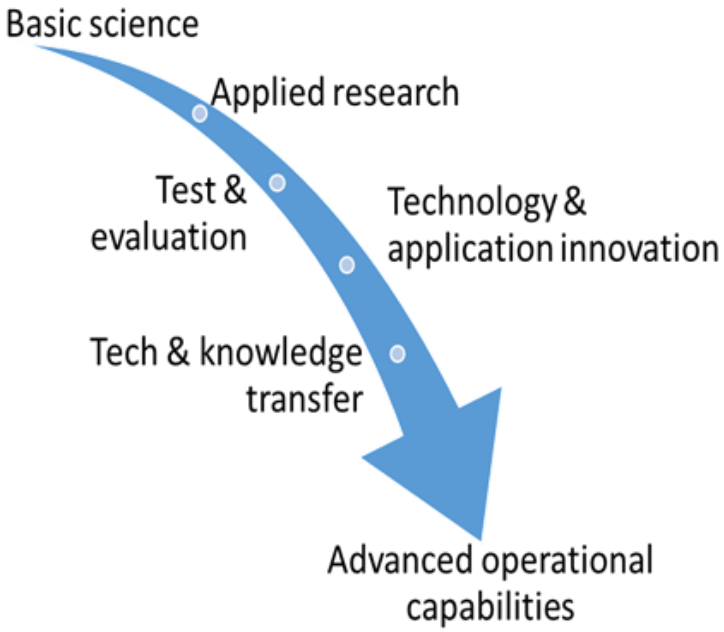
- We work nearly exclusively with single-purpose detection dogs

CPS Mission & Functions

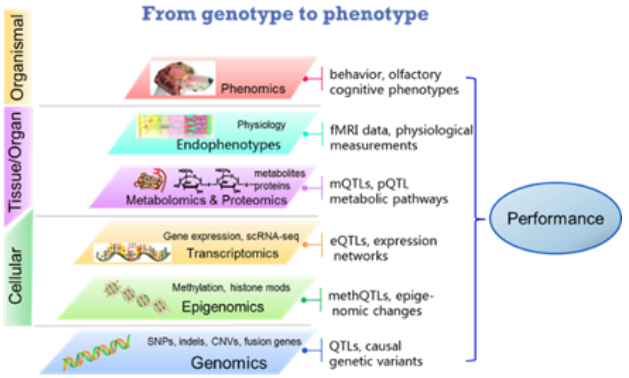
Mission

To innovate detection canine technology by exploring basic and applied research frontiers in olfaction, behavior, cognition, neuroscience, genomics, and physical performance

Functions (what CPS does)



Enhancing U.S. Domestic Production of Detector Dogs



Canine Performance Sciences

Advancing Detection Canine Technology

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Legacy of Game-changing Innovation

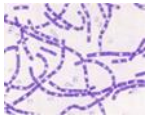
Patents 2015 #8,931,327; 9736,426; 2017 #9763,426 &; 2018 #10123509

Improvised Device Defeat (IDD) Dog

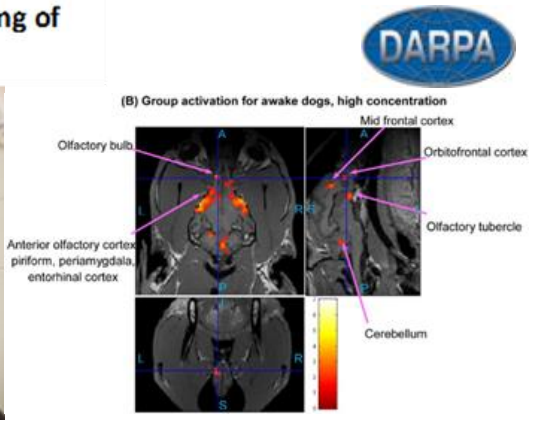
"The dogs enhanced the Battalion's effectiveness times ten"
LtCol J. McGrath, Battalion CMDR

Future of Discovery & Emerging Threats

Real-Time Detection of Virus & Bacteria



Functional Magnetic Resonance Imaging of Awake and Unrestrained Dogs



T. Angle, T. Passler, P. Waggoner, T. Fischer, B. Rogers, P. Galik, & H. Maxwell (2016). *Real-time detection of a virus using detection dogs*. Frontiers in Veterinary Science, vol. 2, 79, pp.1-6. Doi: 10.3389/fvets.2015.00079.

H. Jia, O. Pustovyy, P. Waggoner, R. Beyers, J. Schumacher, C. Wildey, J. Barret, E. Morrison, N. Salibi, T. Denney, V. Vodyanoy and G. Deshpande (2014). *Functional MRI of the olfactory system in conscious dogs*. PLoS One, vol. 9, no. 1, p. e86362.

Canine Performance Sciences

Breeding Program Structure

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Breeding → Pregnancy and Whelping → Birth to 7 weeks: Early Development at CPS → 7 wks to 6 months: Intermediate Development at CPS → 6 to 10 months: Intermediate Development at Prisons → 10 to 12 months: Final Evaluation/ Placement

Shrinking Availability of Detection Dogs

- Broader recognition of detector dog as most effective counterterrorism tool available is increasing world-wide demand
- Growing specialization of detector dog applications
  - Military specialties – IED; cargo, person-screening, ecological, agricultural etc…
- Increasing sophistication of detector dog practitioners
- Higher demand for more capable candidate detector dogs

- **Supply of dogs exhibiting suitable characteristics to perform contemporary detection tasks has declined**

Canine Performance Sciences

Detector Dog Production Research

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- Determine evaluative characteristics that are relevant to operational requirements

- Production aim = physically & behaviorally capable of *Vapor Wake®*
  - Independent but with high trainability
  - Air scenting
  - High vigilance/low distractibility in searching for & alerting to targets (obedience to odor)
  - Deference for searching vs. social interaction with people
  - Environmental soundness in extreme work environments – large event/sporting venues, mass transit, urban clutter
- Specific defining characteristics important to *Vapor Wake®* performance that define the *Auburn Dog™*
- Breeding + early development + initial training = outcome

The Auburn Dog™

Canine Performance Sciences

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8 *Auburn Dogs™* with NYPD Counterterrorism Unit Graduates of VWK9 *Vapor Wake® Class*

I. Overview of behavioral assessments; what we've done and what we've learned

II. Current and future directions in assessing, identifying, and breeding for improved behavior

Behavioral Phenotype

What is the Auburn Dog™ Behavioral Phenotype?

Retrospective analysis of CPS behavior evaluations

N=157 between 2014-2016

3, 6, 10, 12 mo

frontiers in Veterinary Science

ORIGINAL RESEARCH
published: 20 March 2018
doi: 10.3389/fvets.2018.00050

Investigation of the Behavioral Characteristics of Dogs Purpose-Bred and Prepared to Perform *Vapor Wake*® Detection of Person-Borne Explosives

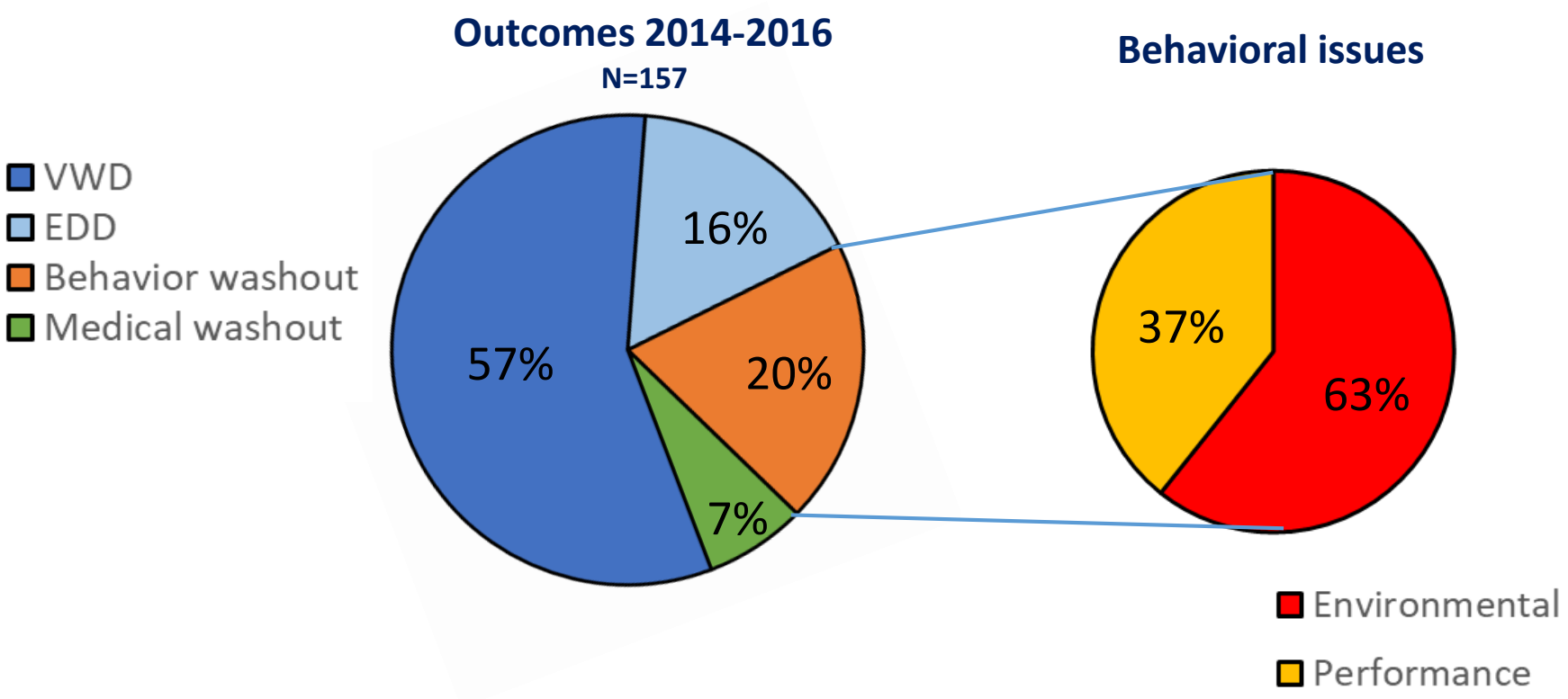
*Lucia Lazarowski[1,2], Pamela Sue Haney[1], Jeanne Brock[1], Terry Fischer[1], Bart Rogers[1], Craig Angle[1], Jeffrey S. Katz[2] and L. Paul Waggoner[1]**

[1]Canine Performance Sciences Program, College of Veterinary Medicine, Auburn University, Auburn, AL, United States, [2]Department of Psychology, College of Liberal Arts, Auburn University, Auburn, AL, United States

Performance	Retrieve
	Hunt
	Focus
	Possession
	Independence
	Work effort
	Air scenting
Environmental Soundness	Surfaces
	People
	Clutter
	Startles
Trainability	Overall

- Dogs in service
  - VaporWake®
  - Standard EDD
- Dogs unsuitable for service (washouts)

Results


Outcomes 2014-2016
N=157
VWD
EDD
Behavior washout
Medical washout
16%
57%
20%
7%
Behavioral issues
37%
63%
Environmental
Performance

Defining Behavioral Phenotype

Comparison of individual characteristic scores averaged across time points

TABLE 2 | Mean (standard error) scores for each group by measure, collapsed across time points.

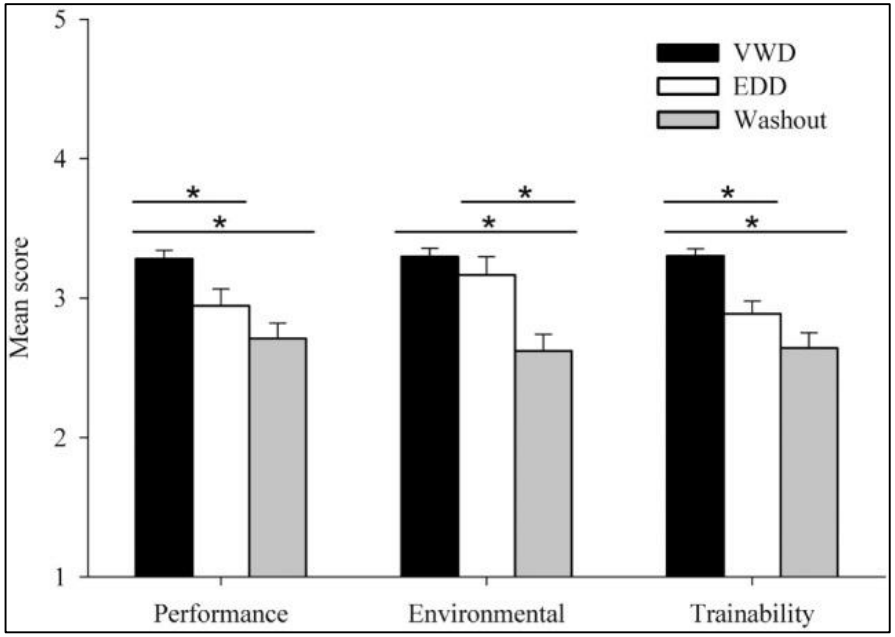
		VWD	EDD	Washout
Performance	⊗ Retrieve	3.07 (0.05)	3.03 (0.11)	2.84 (0.107)
	→ Hunt	3.31 (0.06)^{EDD,W}	2.93 (0.12)	2.87 (0.116)
	→ Focus	3.23 (0.06)^{EDD,W}	2.84 (0.12)	2.63 (0.121)
	→ Possession	3.03 (0.06)^{EDD,W}	2.62 (0.13)	2.67 (0.125)
	→ Independence	3.26 (0.06)^{EDD,W}	2.95 (0.12)	2.79 (0.12)
	→ Work effort	3.24 (0.06)^{EDD,W}	2.93 (0.115)	2.67 (0.118)
	⊗ Air scenting	3.06 (0.07)	2.79 (0.140)	2.99 (0.136)
Environmental	⊗ Surfaces	3.23 (0.05)^{W}	3.22 (0.09)	3.01 (0.08)
	⊗ People	3.28 (0.06)^{W}	3.16 (0.11)	2.86 (0.10)
	⊗ Vehicles	3.27 (0.05)^{W}	3.13 (0.11)	2.90 (0.09)
	⊗ Visual startle	2.96 (0.10)^{W}	2.98 (0.21)^{W}	2.17 (0.18)
	⊗ Acoustic startle	3.13 (0.09)^{W}	2.88 (0.19)^{W}	2.06 (0.16)
	⊗ Excitability	2.98 (0.04)	2.92 (0.07)	2.93 (0.07)
General	→ Trainability	3.26 (0.05)^{EDD,W}	2.82 (0.10)	2.69 (0.10)

^{EDD}Denotes that score was significantly higher than the explosives detection dog (EDD) group at the 0.05 level.

^{W}Denotes that score was significantly higher than the Washout group at the 0.05 level.

Defining Behavioral Phenotype

- Distinct behavioral differences between **VaporWake™**, **EDD**, and **Washout** dogs
  - Performance-related traits differentiated VWD from EDDs, not Environmental Soundness
  - Environmental soundness greatest factor for serviceably as a working dog
- Service-quality dogs not necessarily reflect breeding quality
- Enhanced early conditioning/ experience can "boot-strap" (overcome) less than ideal genetics making selecting breeders using traditional characteristics less effective



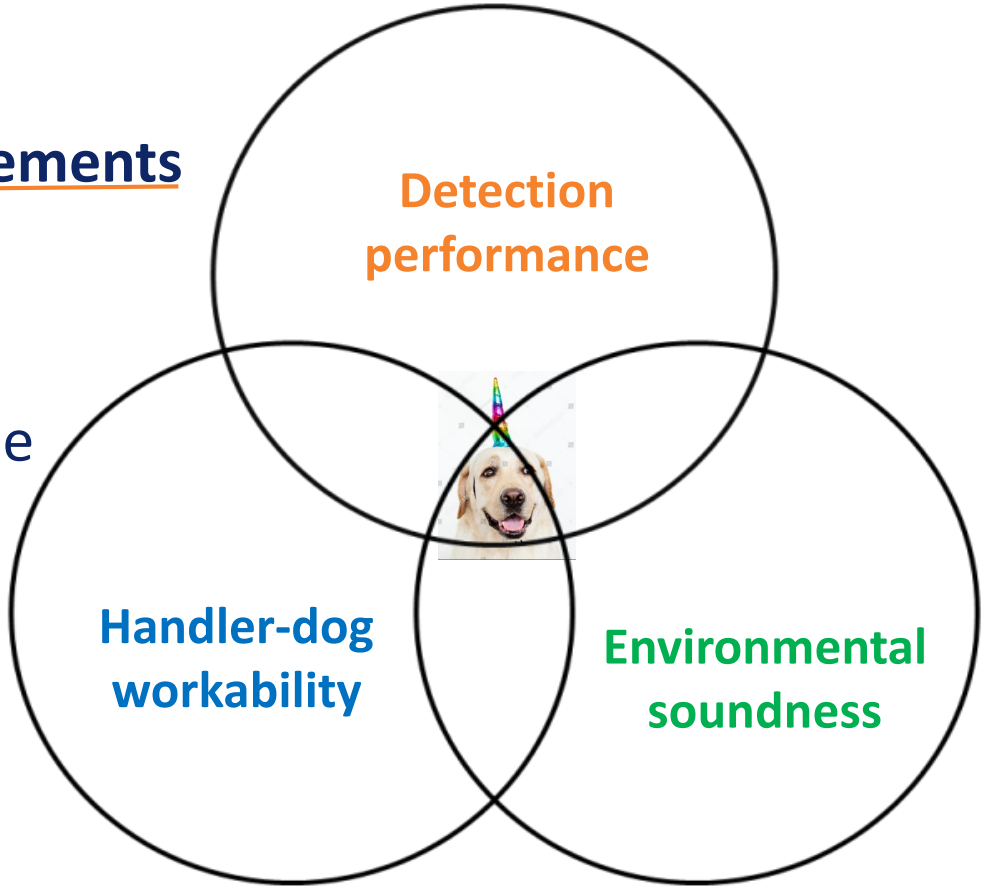
Lazarowski et al. (2018)

Need additional analogue quantitative measures

Breeder Behavioral Requirements

CPS Breeder Behavioral Requirements

- Excellent hunt and air-scenting
- Deference for searching vs. social interaction with people
  - Balance between independence and trainability
- Focused, persistent, and composed when faced with difficult challenges
- Resilience in extreme work environments

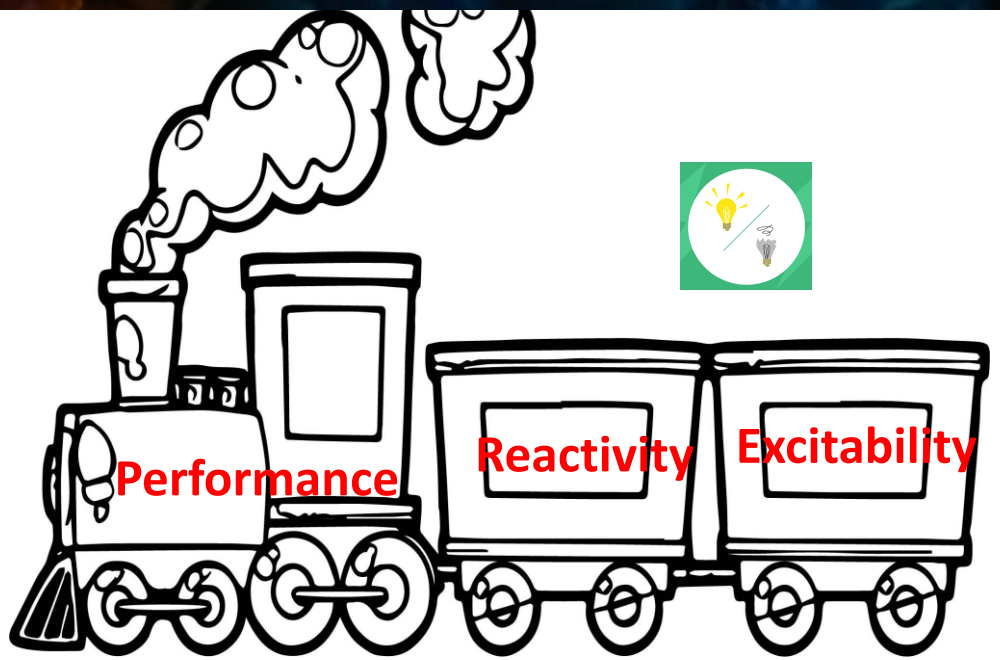


How to find unicorns?

Building a Better Detector Dog

Disentangling performance & environmental soundness

- **Environmental soundness??**
  - ➢ **Reactivity**
  - ➢ **Anxiety**
  - ➢ **Excitability – positive/negative**
  - ➢ **Cognitive/emotional competence**
- **Theorize that reactivity, anxiety, negative excitability *hitched to and being pulled along by high performance selection***



- **But we know that the "unicorns" do exist**
  - ➢ **Low reactivity, controlled excitability, cognitive/emotional competence + very high working performance**
- **Need new paradigms for assessment with higher resolution of / sensitivity to desired characteristics**
  - ➢ **Cognitive-behavioral & neurological metrics to associate with performance and environmental soundness**

Takeaways

- Refine definitions/measurement to gain better resolution of important traits
- Early prediction
- Improve environmental soundness
- Genetic vs. environmental

Approaches

I. Improve behavioral assessments

II. Emphasis on early development

I. Refinement of Behavior Evaluations

Incorporation of cognitive assessments

frontiers in Veterinary Science
ORIGINAL RESEARCH
published: 04 October 2018
doi: 10.3389/fvets.2018.00236

Enhanced Selection of Assistance and Explosive Detection Dogs Using Cognitive Measures

Evan L. MacLean [1,2] and Brian Hare [3,4]*

[1] School of Anthropology, University of Arizona, Tucson, AZ, United States, [2] Department of Psychology, University of Arizona, Tucson, AZ, United States, [3] Evolutionary Anthropology, Duke University, Durham, NC, United States, [4] Center for Cognitive Neuroscience, Duke University, Durham, NC, United States

Cognitive testing

N= 81 @ 3, 6, and 11 mo

Cognitive Domain	Sub-domain	Test
Social	Communication	Gesture following
		Help solicitation
	Empathy	Emotion contagion
Physical	Reasoning	Causal cues
	Spatial navigation	Barrier detour
	Object permanence	Spatial transpositions
General	Executive Functions	Working memory
		Self control
		Attention
	Motivation	Persistence
		Emotion regulation

Duke University Dog Cognition Test Battery

Traditional behavior evaluations

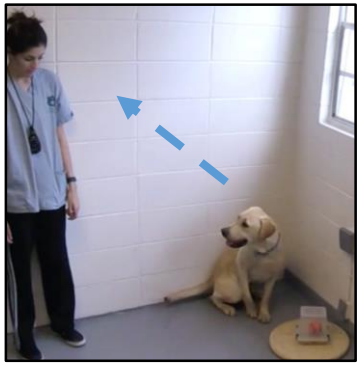
Performance	Retrieve
	Hunt
	Focus
	Possession
	Independence
	Work effort
	Air scenting
Environmental Soundness	Surfaces
	People
	Clutter
	Startles
Trainability	Overall

Final outcome:

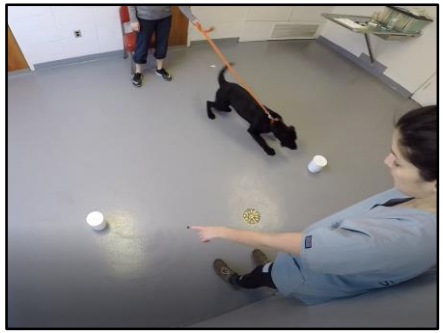
- ☑ Success
- ☒ Washout

I. Refinement of Behavior Evaluations: Cognitive assessments

Joint attention

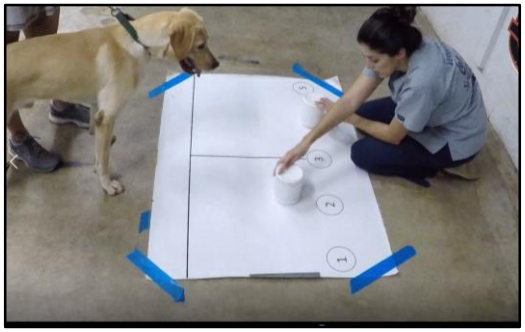


Social bias

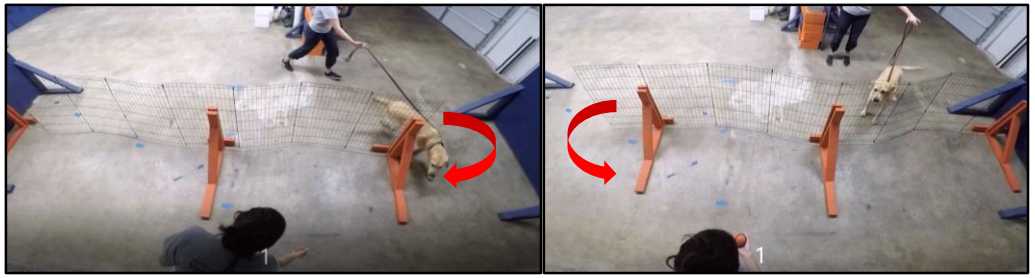


Inhibitory control

Problem-solving

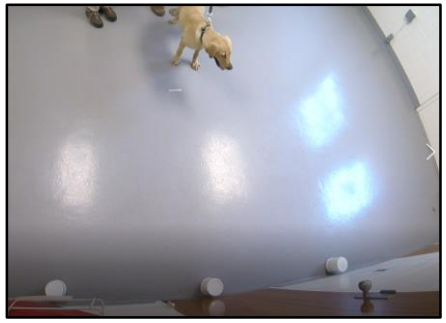


Behavioral flexibility



Persistence

Attention/Memory



I. Refinement of Behavior Evaluations: cognitive assessments

1) Relationships between cognitive abilities, behavioral evaluations, and outcome

- Problem-solving speed
- Accuracy success
- Attention
- Cognitive flexibility
- Persistence/motivation
- Social sensitivity*
- Arousal

2) Early indicators of future success

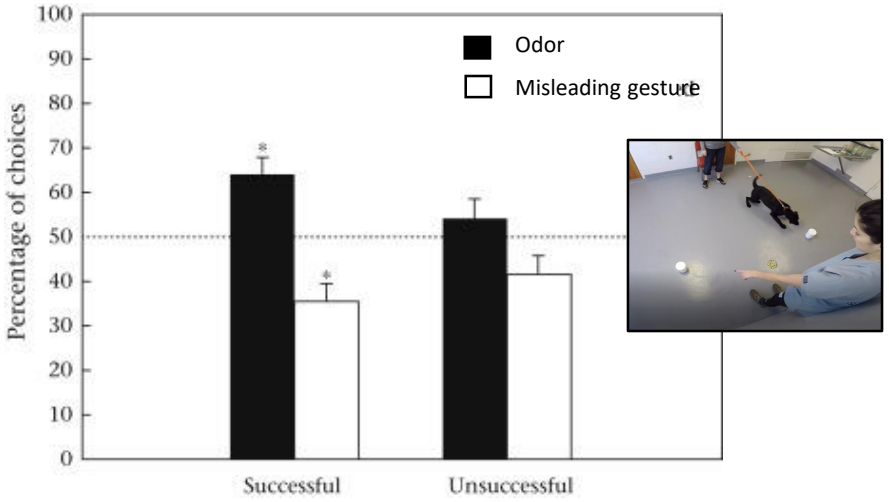
- Evident as early as 3 months

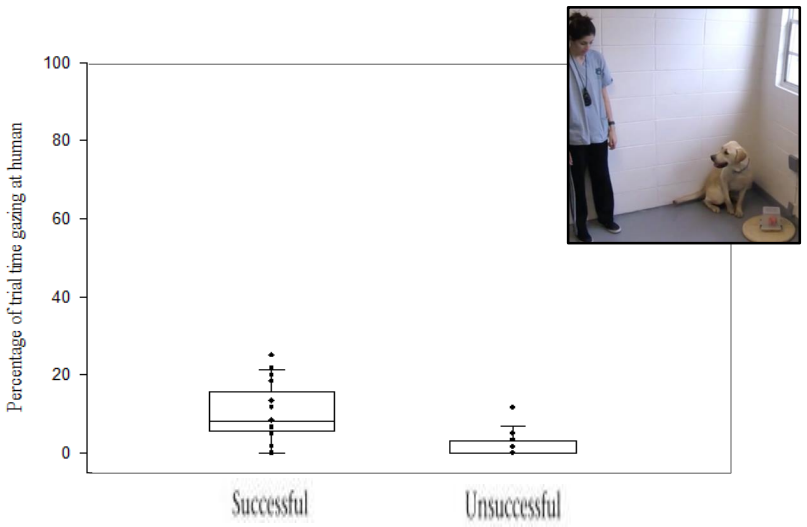
Takeaways

Cognitive domains underlie important detection dog characteristics

- **More objective and reliable**
- **Validate existing measures**
- **Complementary**

Lazarowski et al. (in Press). Persistence and human-directed behavior in detection dogs: ontogenetic development and relationships to working dog success. *Animal Behaviour*





The role of arousal in problem solving and performance

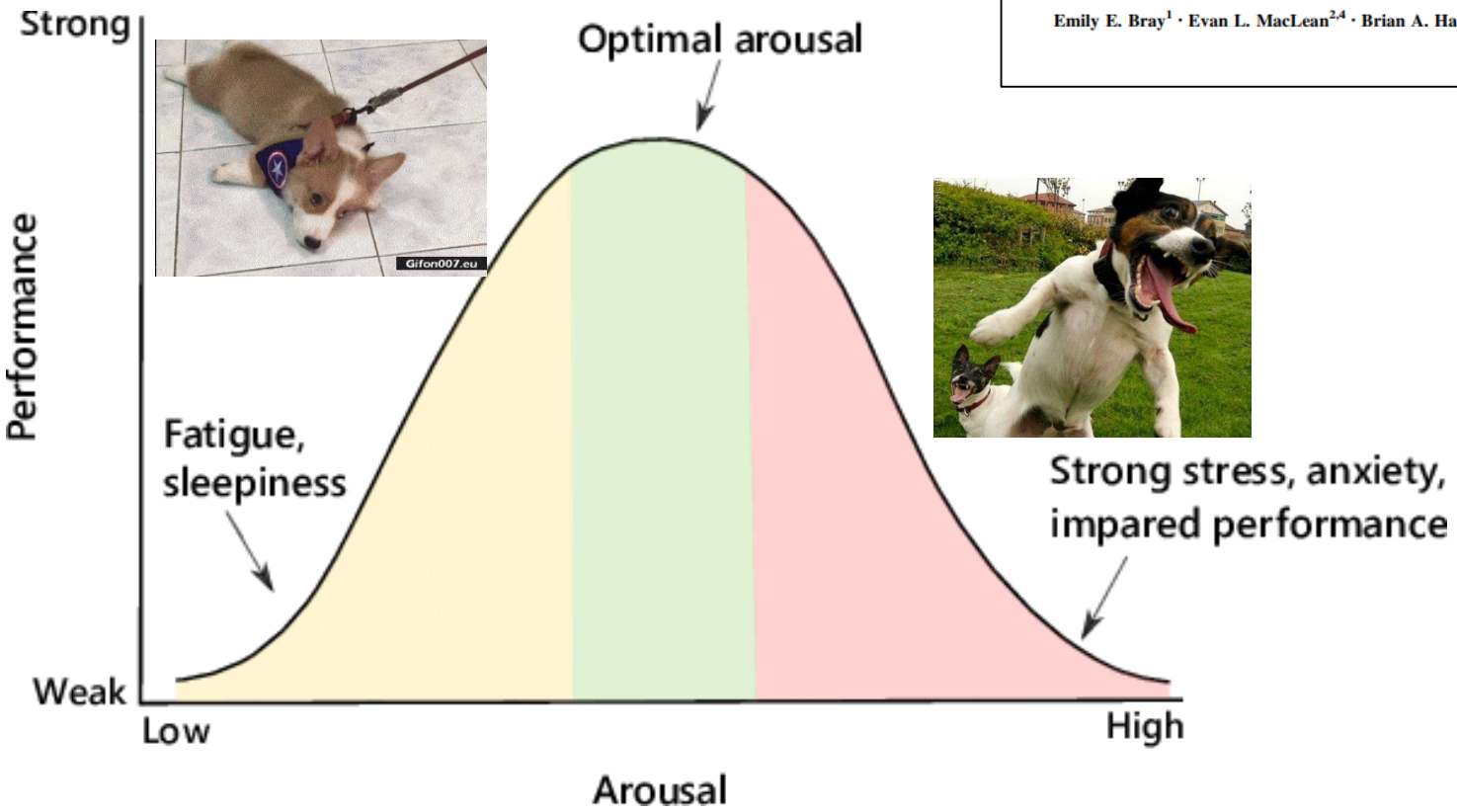
Anim Cogn (2015) 18:1317–1329
DOI 10.1007/s10071-015-0901-1

ORIGINAL PAPER

Increasing arousal enhances inhibitory control in calm but not excitable dogs

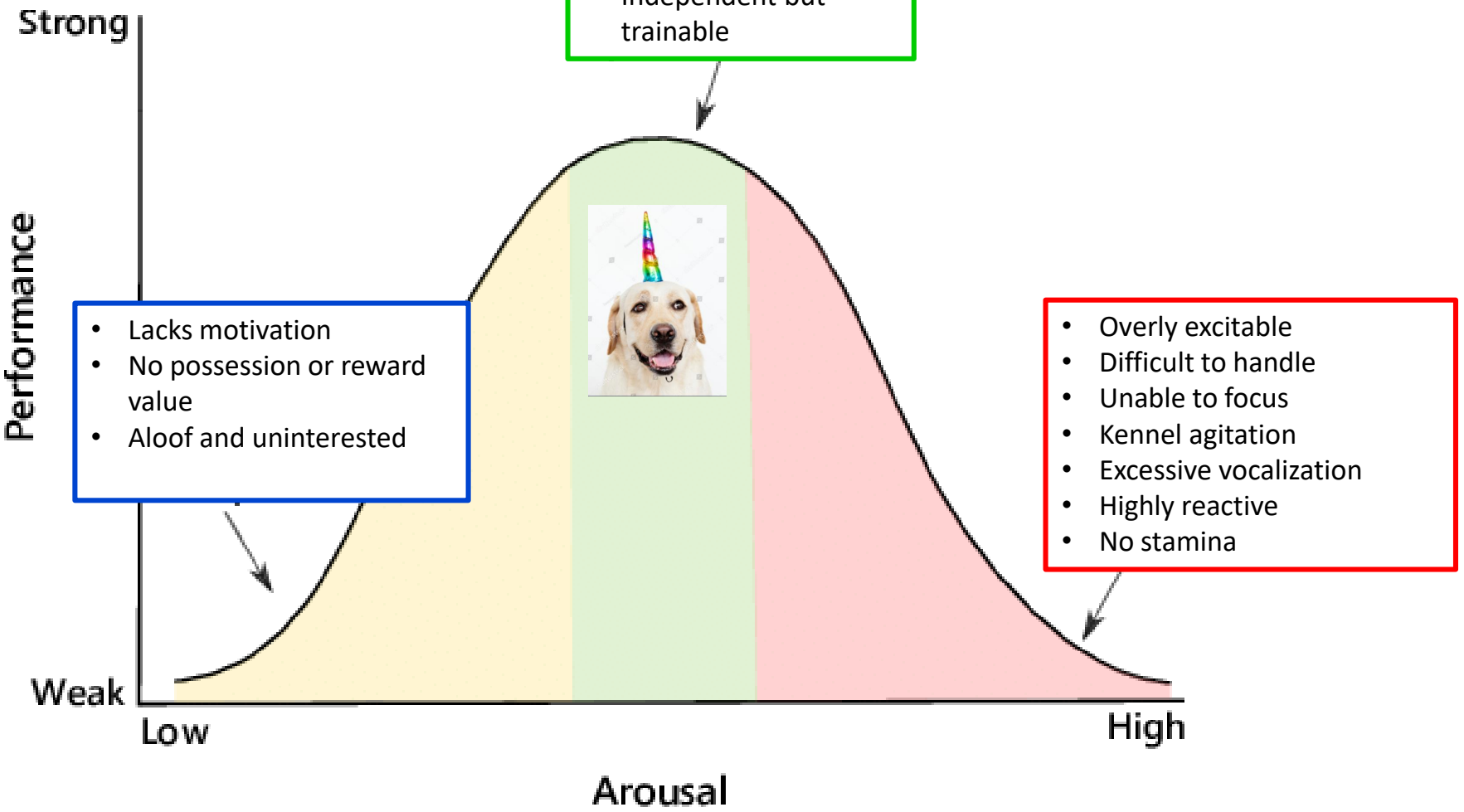
Emily E. Bray[1] · Evan L. MacLean[2,4] · Brian A. Hare[2,3]

Yerkes-Dodson law



I. Refinement of Behavior Evaluations

- Strong motivation
- Focused energy
- Manageable
- Independent but trainable



- Lacks motivation
- No possession or reward value
- Aloof and uninterested

- Overly excitable
- Difficult to handle
- Unable to focus
- Kennel agitation
- Excessive vocalization
- Highly reactive
- No stamina

I. Refinement of Behavior Evaluations

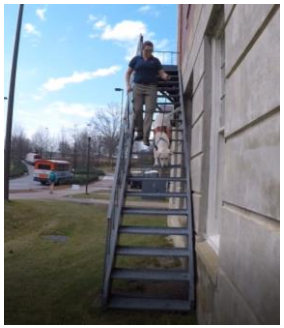
Behavior Evaluations, 2.0

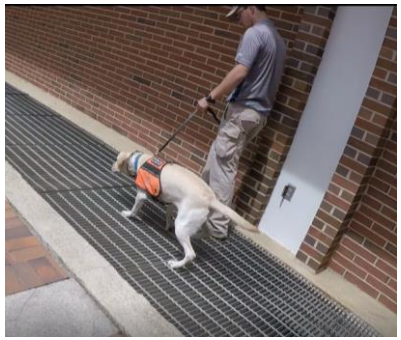
Handler-dependent ← **Balance** → Too independent

I. Refinement of Behavior Evaluations

Behavior Evaluations, 2.0

- Adoption of ***The Behavior Checklist*** (Dr. James Serpell, U Penn) for environmental soundness measures
  - Standardized and validated
  - Can be used for genetic analysis with Estimated Breeding Values (EBVs)





IWDBA

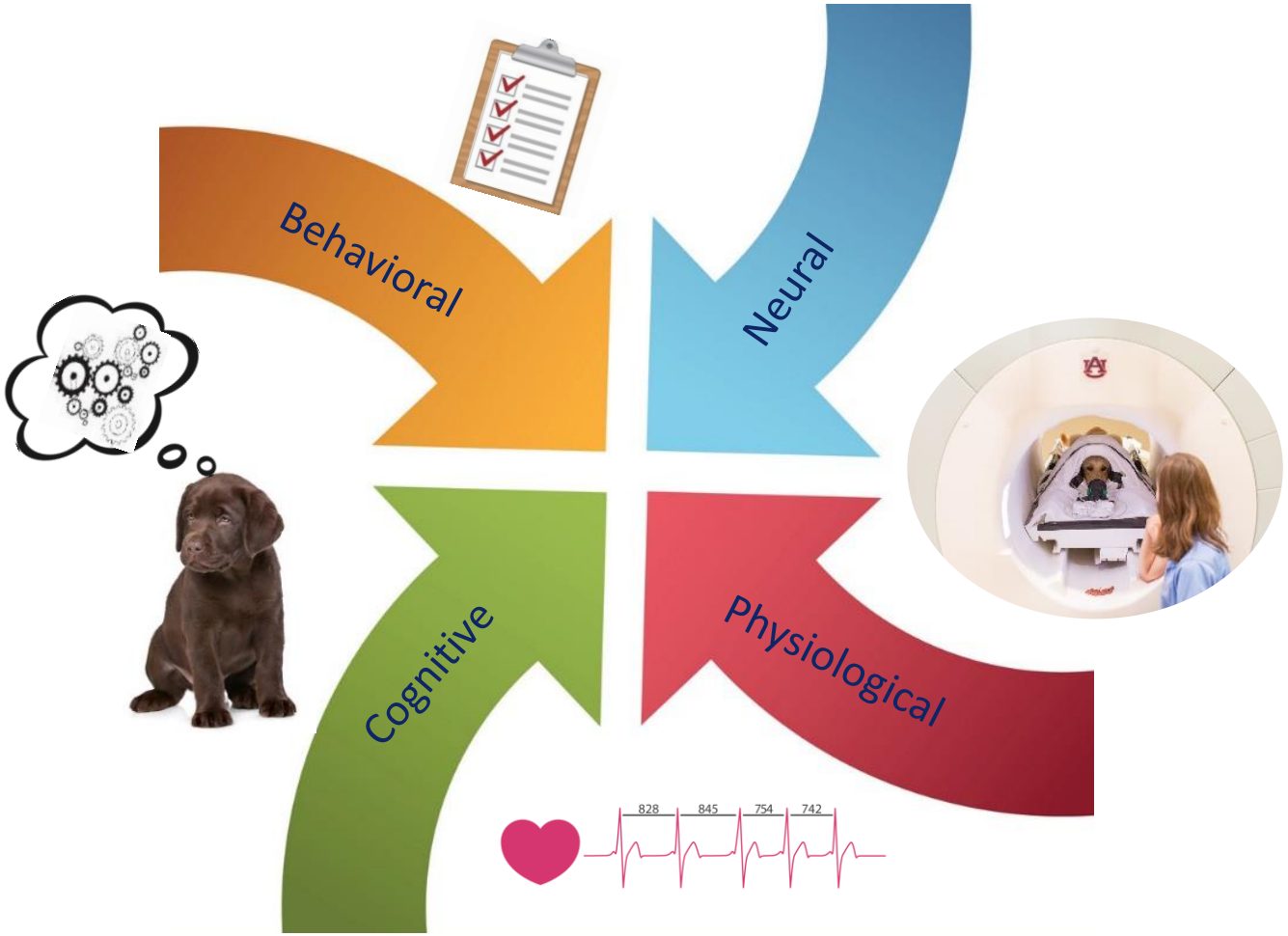
1 - Behavior Checklist (BCL) Scoring System

- **BCL General Overview**
- BCL Form Downloads
- Definitions (Download Page ~ Alt. Languages)
- > 1 - Anxious in Unfamiliar Situations
- > 2 - Fear of Noises
- > 3 - Fear of Novel Objects
- > 4 - Fear of Underfootings
- > 5 - Fear of Dogs
- > 6 - Fear of Stairs
- > 7 - Fear of Traffic
- > 8 - Separation Anxiety
- > 9 - Hyper-Attachment
- > 10 - Fear of Strangers
- > 11 - Body Handling Concern
- > 12 - Retreats when Reached for
- > 13 - Harness Sensitivity

Guiding Eyes for the Blind

The Seeing Eye®

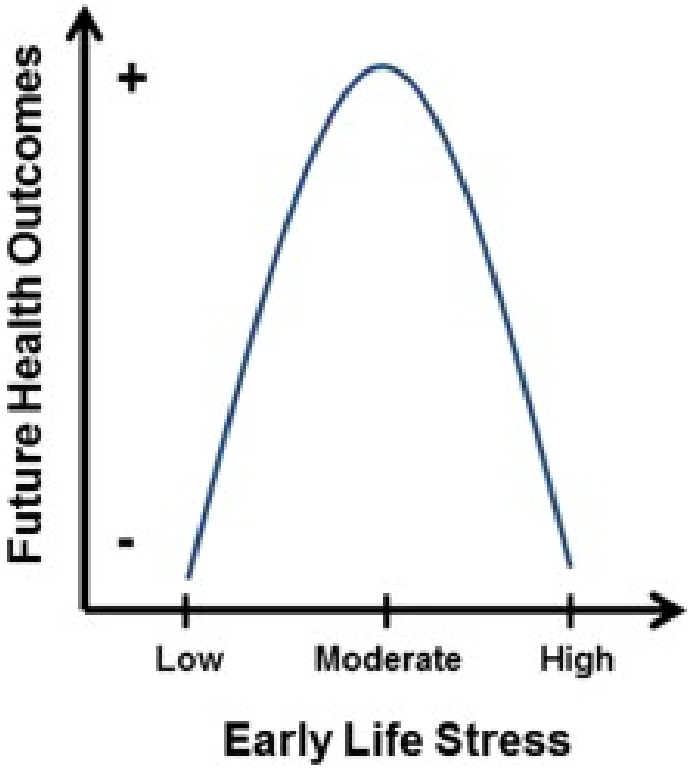
Validation with other measures



II. Emphasis on Early Development

The role of Early Life Stress (ELS)

- Chronic or severe ELS can be traumatic
- Mild-moderate ELS:
  - Promotes resilience
  - Enhances problem-solving abilities
  - Self-regulation of arousal
  - “Stress inoculation”



II. Emphasis on Early Development

Enhanced early socialization

- Introduction of “small challenges”:
  - Brief separations
  - Individual enhanced socialization
  - Multi-sensory stimulation

Contents lists available at ScienceDirect
Applied Animal Behaviour Science
journal homepage: www.elsevier.com/locate/applanim

Research paper

Improving puppy behavior using a new standardized socialization program

Helen Vaterlaws-Whiteside*, Amandine Hartmann
Guide Dogs National Breeding Centre, Banbury Road, Bishops Tachbrook, Warwickshire, CV33 9WT, United Kingdom

- Maternal interactions
  - Population specificity?

PNAS

Effects of maternal investment, temperament, and cognition on guide dog success

Emily E. Bray[a,b,1], Mary D. Sammel[c], Dorothy L. Cheney[d,1], James A. Serpell[e], and Robert M. Seyfarth[a]
[a]Department of Psychology, University of Pennsylvania, Philadelphia, PA 19104; [b]School of Anthropology, The University of Arizona, Tucson, AZ 85
[c]Department of Biostatistics, Epidemiology and Bioinformatics, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA 19104;
[d]Department of Biology, University of Pennsylvania, Philadelphia, PA 19104; and [e]Department of Clinical Studies, School of Veterinary Medicine, Univ
of Pennsylvania, Philadelphia, PA 19104

Contributed by Dorothy L. Cheney, June 21, 2017 (sent for review April 3, 2017; reviewed by Sarah Marshall-Pescini and Karen J. Parker)

PUBLIC HEALTH

Coddled Puppies Make Poor Guide Dogs, Study Suggests

August 7, 2017 · 3:44 PM ET
Heard on All Things Considered

Credit: Courtesy of The Seeing Eye; Bray et al. (2017)

Remaining Questions and Current/Future Directions

- Link between high performance-reactivity?
  - Biological underpinnings of sensitivity to rewards/aversives
- Influence of genetics and behavior
  - Maternal influences and epigenetics
  - Gut/brain/behavior axis

Cognitive parameters of scent detection

- Learning capacity
- Memory duration and capacity
- Limits of detection
  - Threshold, generalization

Thank You

Partners and Collaborators

Office of Naval Research – Science & Technology

[dstl]

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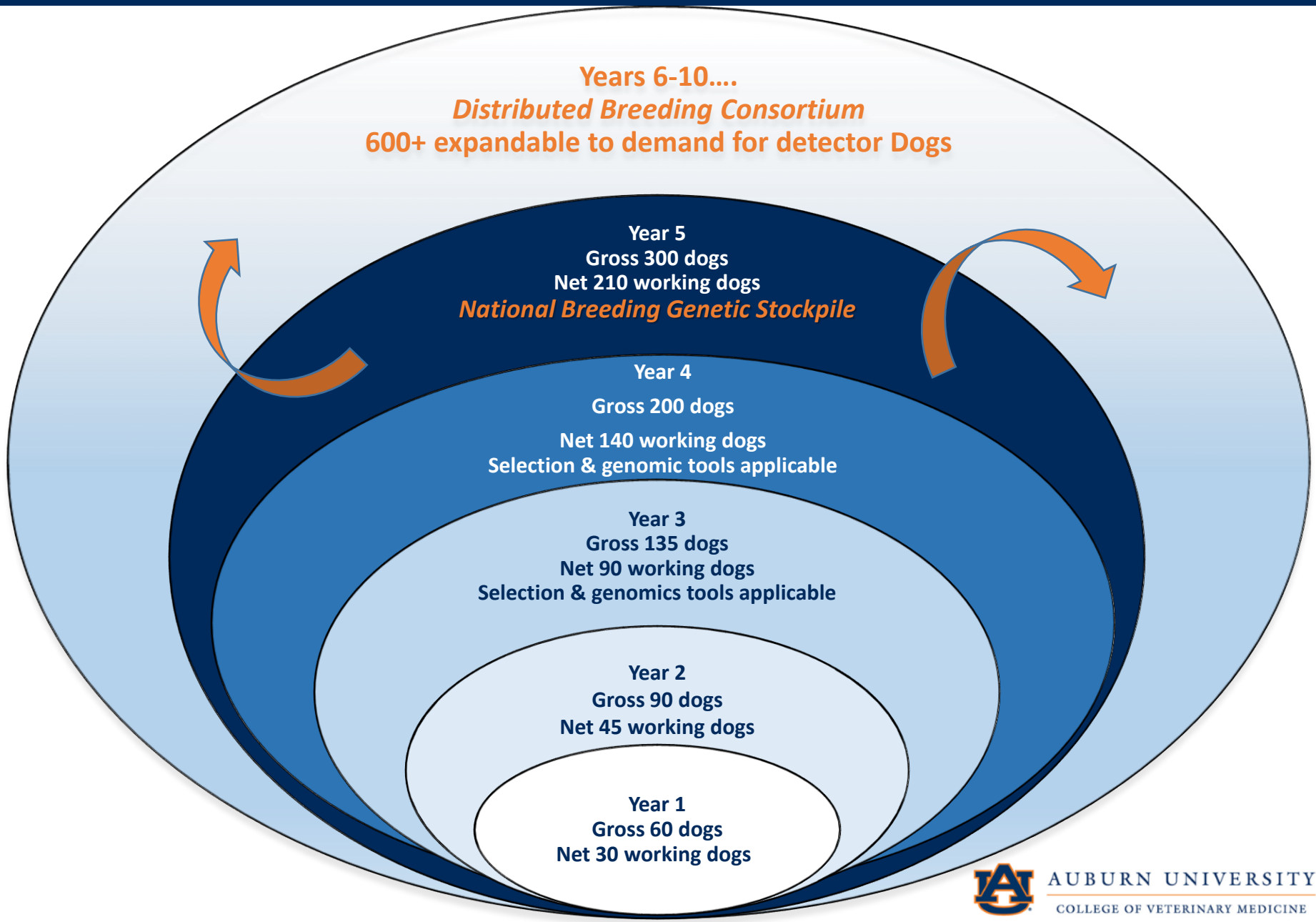
Breeding program support

IWDB Board for 20 Years of Supporting the Working Dog Community

Canine Performance Sciences

Creating a U.S. Domestic Supply of Highest Quality Detector Dogs



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