INTRODUCTION & MEASURING ANIMAL BEHAVIOR

Photo courtesy: USDA
What is behavior?

• “Aggregate of responses to internal and external stimuli”
  - Dictionary.com

“The response of an individual, group, or species to its environment”
  - Merriam-Webster

“The action, reaction, or functioning of a system, under normal or specified circumstances”
  - Collins English Dictionary
People

• Konrad Lorenz, Nikolaas Tinbergen, Karl von Frisch; 1973 Nobel Prize in Physiology or Medicine
• Temple Grandin
Fields and Terms in Animal Behavior

- Ethology (the science of animal behavior)
- Physiology and behavior
- Brain mechanisms of behavior (Neuroethology)
- Evolution of behavior
- Descriptions of behaviors (the Ethogram)
- Development of behavior (ontology)
- Applied animal behavior
- Psychology
The “why” of behavior:

Tinbergen’s 4 questions:
• Function -- What is the function of the behavior? (evolutionary adaptation)
• Phylogeny (evolutionary development)
• Mechanism/causation
• Ontogeny (development)

Example: Dog barking
• Function: communication within and between animals
• Phylogeny: barking developed as a way to socialize, warn, call others, etc.
• Mechanisms: which part of the brain causes barking
• Development: how does barking develop from puppy to adult?
Animal behavior and human significance

Benefits of understanding animal behavior:

- Child development and care
- Language analogues
- Early warning of environmental damage
- Population management
- Developments in domestic animal welfare
- Production industry efficiency
- Making better pet owners (better for the animal and the human)

Image courtesy: http://www2.gsu.edu/~wwwlrc/3476.html
Proximate importance of behavioral observation

- Understand the effects of disease, stress, etc.
- Understand social organization
- Improve management techniques
- Improve animal welfare
- Understand companion animal behavior to improve care

Photo courtesy: www.colostate.edu
Where to begin?

• You will likely have an animal or topic of interest that helps when choosing a subject.
• May need to narrow options down from a generalized population.
  • Use of cows as a representative model of ruminants.
• Questions typically originate from observations.
• You should be familiar with your species of choice before beginning study.
  • Behaviors that would be bizarre in one species may be completely normal for another species.
Getting to know your species

• Read up on the topic.
• May need to conduct an initial survey of a population
  • Recognition of patterns
  • Help formulate the hypothesis
• By knowing what is normal, you can decide how specific/generalized your observations need to be to answer the question.
1) How many animals should be observed?
   - Unless you are focusing on a very small, specific subset of a population, it is typically ideal to observe as many animals as possible.
   - Ideally you should be able to identify individual animals.
   - Make sure the number you plan to observe will give you statistically sound results.
Designing the observation study: approaches

**Focal approach**
- Focus on a single individual
  - Pre-determined characteristic
  - Randomly chosen
- Describe behaviors in sequence
- Determine the duration of the behavior

**Survey approach**
- Watch many individuals at the same time
- Count the number of individuals engaged in each behavior
- More generalized idea of population behavior
Designing the observation study: behaviors

2) How should behaviors be described?
   - Develop a comprehensive catalog from the initial study.
     - Give each behavior a term and a description.
   - Differentiate between the actual behavior and its perceived function.
   - Quantify behaviors
     - Distance moved
     - Time spent eating
   - Consider adding subjective scores of qualitative behaviors
   - Note the context in which the behavior occurred.
Designing the observation study: behaviors

Individual Behaviors

- Also referred to as an “event”.
- Refers to each behavior as its own unique occurrence
  - Walking, jumping, running
  - Best summarized as number of events per time period.

Grouped Behaviors

- Also referred to as a “state”.
- Refers to a collection of similar behaviors
  - Walking, jumping and running = locomotion
  - Best summarized as duration of behavior.
Designing the observation study: making observations

• Is live observation or video-recording better?
  • Things to consider:
    • Time constraints
    • Will your presence affect the animal’s behavior?
    • Availability of a power source
    • Availability of personnel
Summarizing the results: the ethogram

- Catalog of behaviors.
- May cover one class of behaviors
  - Vocalization = whining, barking, growling, etc.
- May cover a wide range of behaviors.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head in food/water dish</td>
<td>Cat is actively eating or drinking; or, cat is showing significant interest in food or water</td>
</tr>
<tr>
<td>Sitting or Lying – not touching</td>
<td>Cat is sitting or lying with no body part in direct contact of other individual.</td>
</tr>
<tr>
<td>Sitting or Lying – touching</td>
<td>Cat is sitting or lying with some part of body in direct contact of other individual.</td>
</tr>
<tr>
<td>Aggression</td>
<td>Cat is actively engaged in fighting, hissing, or dominance behavior.</td>
</tr>
<tr>
<td>In litterbox – not using</td>
<td>Cat is sitting, standing, or lying inside litterbox, but is not actively using it.</td>
</tr>
<tr>
<td>Using litterbox</td>
<td>Cat is urinating or defecating inside litterbox.</td>
</tr>
<tr>
<td>Grooming self</td>
<td>Cat is grooming own body.</td>
</tr>
<tr>
<td>Grooming other</td>
<td>Cat is grooming body of other individual.</td>
</tr>
<tr>
<td>Sleeping</td>
<td>Cat is lying in a relaxed state with eyes closed.</td>
</tr>
<tr>
<td>Neutral social interaction</td>
<td>Cat is engaged in non-aggressive interaction with other individual, such as nose-touching or rubbing.</td>
</tr>
<tr>
<td>Locomotion</td>
<td>Cat is walking, pacing, running, or climbing.</td>
</tr>
<tr>
<td>Play</td>
<td>Cat is engaged in activity for sake of amusement; either alone or with other individual.</td>
</tr>
</tbody>
</table>
Summarizing the results: time budgets

- Percentage of total observation time animal spends in each behavior.
- Easy to derive from raw data.
- May be easier for audience to understand than behavior counts.

<table>
<thead>
<tr>
<th>PER</th>
<th>TRT</th>
<th>SIT</th>
<th>LAY</th>
<th>STAND</th>
<th>MOVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>28%</td>
<td>62%</td>
<td>7%</td>
<td>3%</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>15%</td>
<td>82%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>3%</td>
<td>68%</td>
<td>8%</td>
<td>20%</td>
</tr>
<tr>
<td>1</td>
<td>B</td>
<td>25%</td>
<td>67%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>25%</td>
<td>73%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>28%</td>
<td>65%</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>1</td>
<td>C</td>
<td>3%</td>
<td>92%</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>2</td>
<td>C</td>
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<td>75%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>27%</td>
<td>68%</td>
<td>3%</td>
<td>2%</td>
</tr>
</tbody>
</table>
Summarizing the results: transition matrix

- A transition matrix expresses the probability that behaviors occur in a sequence.
- Allows for easier recognition of behavioral complexes and relationships.
- Rows = preceding behavior,
- Columns = succeeding behavior.

<table>
<thead>
<tr>
<th>Input</th>
<th>A=0</th>
<th>A=1</th>
<th>A=2</th>
<th>A=3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lay</td>
<td>sit</td>
<td>stand</td>
<td>walk</td>
</tr>
<tr>
<td>A=0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lay</td>
<td>89.5%</td>
<td>4.4%</td>
<td>5.9%</td>
<td>0.2%</td>
</tr>
<tr>
<td>sit</td>
<td>4.9%</td>
<td>90.9%</td>
<td>1.9%</td>
<td>0.0%</td>
</tr>
<tr>
<td>stand</td>
<td>11.2%</td>
<td>3.5%</td>
<td>83.0%</td>
<td>2.2%</td>
</tr>
<tr>
<td>A=1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>walk</td>
<td>4.4%</td>
<td>2.3%</td>
<td>0.0%</td>
<td>90.1%</td>
</tr>
<tr>
<td>A=2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>trot</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>2.8%</td>
</tr>
<tr>
<td>A=3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>canter</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>gallop</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Figure courtesy: Gerencser et al., 2013
Summarizing the results: flow chart

- Makes visualization of a sequence of events easier.
- Can have different formats to emphasize different points.

Ethogram courtesy labworks.hms.harvard.edu/fruitfly/thriller
Conclusions

• Behavior is a complex field of study.
• It is necessary to understand the organism of interest.
• Experimental design must take into account the goal of the research.
• Method of reporting results should be an objective description of the behaviors.
• The discussion begins by re-stating the major results and how they agree or not with the literature; then synthesis the findings in an overall conclusion.

Image courtesy: www.bbc.com