Critical thinking and experimental design: Study Guide One
Study guides aims to provide an opportunity to practice critical thinking and experimental design.

Unit #1
The following example contains a figure from a paper that reported infanticidal behaviour in male house sparrows (Veiga, 2003). Please read the excerpt of the methods and examine the figure to answer the series of questions below.

Scientists tested the hypothesis that infanticide is committed by more fit males and that males that are successful in breeding after committing infanticide have more fit offspring. Data of infanticide was collected over 10-year study (1986–1995). House sparrow colony nesting in nest-boxes at Collado Villalba, Spain, were monitored and number of fledglings from either a non-infanticidal (Only male to breed with female) or infanticidal (Male that took over a nest by removing original males offspring) male. Males house sparrows are predominantly monogamous and most females make two successful reproductive attempts per season. The focus is on the infanticide committed by males that took over and replaced territory owners, and subsequently mated with the victimized female to produce a new clutch.

Veiga, J. P. (2003). Infanticide by male house sparrows: gaining time or manipulating females? *Proceedings. Biological sciences / The Royal Society*, *270 Suppl 1*(August), S87–9. doi:10.1098/rsbl.2003.0027

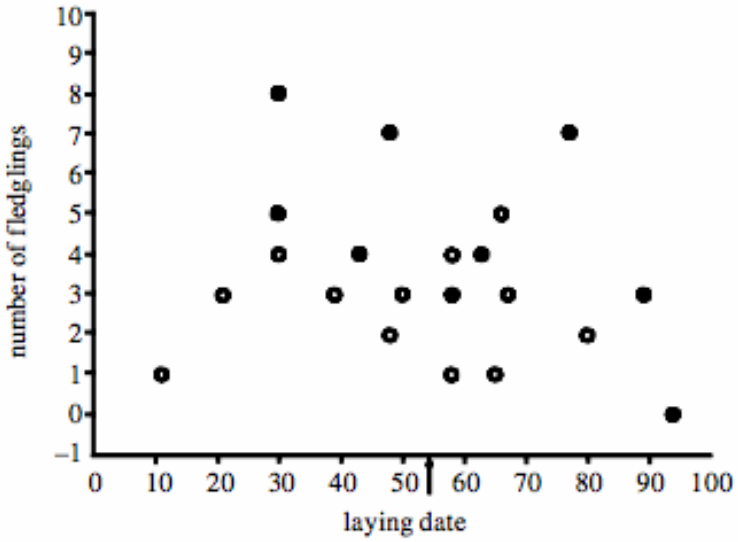


Figure 1. Number of fledglings raised by infanticidal (filled circles) and non-infanticidal (open circles) males after replacement of the previous owner in relation to laying date, expressed as days elapsed after the start of the laying season in each study year. The arrow indicates median laying date.

1) What are the main conclusions from this experiment, in relation to the hypothesis? Explain

2) What is one strength of the experimental design? Explain. (5 pts)

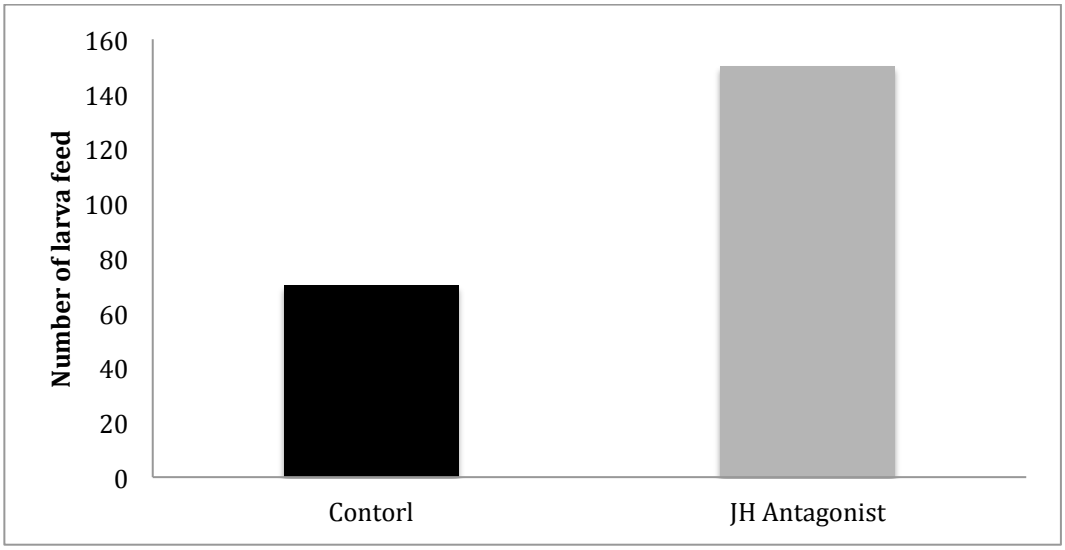
3) What is one weakness of the experimental design? Explain. (5 pts)

4) Describe one other study that has tested this hypothesis. Are the results of that study and the present study consistent? Explain. (5 pts)

5) Describe one follow up study to further test this hypothesis (a study not described in lecture or textbook). Include control groups and predictions. Use your creativity and critical thinking skills. (6 pts)

Unit #2

1. Scientists hypothesized that JH (juvenile hormone) has an effect on the development of honeybee behavior. Researchers administered a JH receptor antagonist (dissolved in saline) to young nurse bees. Bees were randomly assigned to either the control group (no treatment) or the experimental group (n=25 per group). At 8:00am, to administer the JH receptor antagonist to the experimental group, the bees were cooled slightly (to slow them down) and, with a paintbrush, the JH receptor antagonist (in saline) was gently applied to the lower back. All bees then received a small sticker with a unique number on the upper back (#1-25 for the control group, #26-50 for the experimental group). Bees were then monitored for 3 hours, between 11:00am and 2:00pm. The number of larva that each young nurse bee fed was recorded (averages shown below).



1) What are the main conclusions from this experiment, in relation to the hypothesis? Explain. (4 pts)

2) What is one strength of the experimental design? Explain. (5 pts)

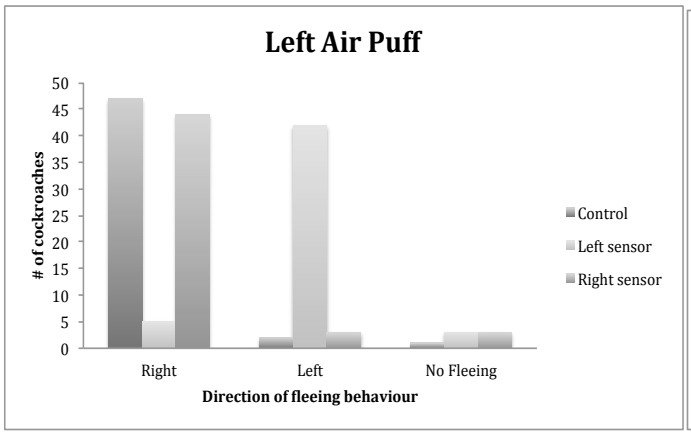
3) What is one weakness of the experimental design? Explain. (5 pts)

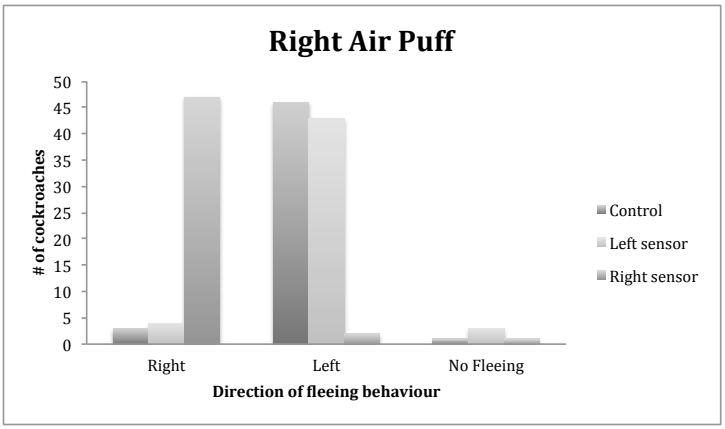
4) Describe one other study that has tested this hypothesis in honeybees. Are the results of that study and the present study consistent? Explain. (5 pts)

5) Describe one follow up study to further test this hypothesis in honeybees (a study not described in lecture or textbook). Include control groups and predictions. Use your creativity and critical thinking skills. (6 pts)

Unit #3

2. An American cockroach can begin to turn away from approaching danger in as little as a hundredth of a second. A cockroach has wind sensors located on its cerci, two thin projecting appendages at the end of its abdomen on either side. Scientist hypothesized that these wind sensors would act to not only register the signal (wind movement) but would also indicate to the cockroach which way to flee from danger (action output). To test this hypothesis experimenters collected 150 cockroaches and brought them into the lab. All cockroaches were anesthetized and randomly assigned into one of three groups, with n=50 per group. The first group had the wind sensor on the left side covered with a thin layer of glue (to reduce any signal). The second group had the same procedure on the right wind sensor. The third group was only placed under the anesthesia (control). The fleeing behavior of the cockroaches was then tested using a air puff machine, which gave an air puff that would be felt by both wind sensors (large puff) but was stronger closer to the air puff machine. Each cockroach was given 2 air puffs, one from the left and one from the right in a random order. The fleeing reaction was measured as what direction the cockroach moved after the air puff was delivered.





1) What are the main conclusions from this experiment, in relation to the hypothesis? Explain

2) What is one strength of the experimental design? Explain. (5 pts)

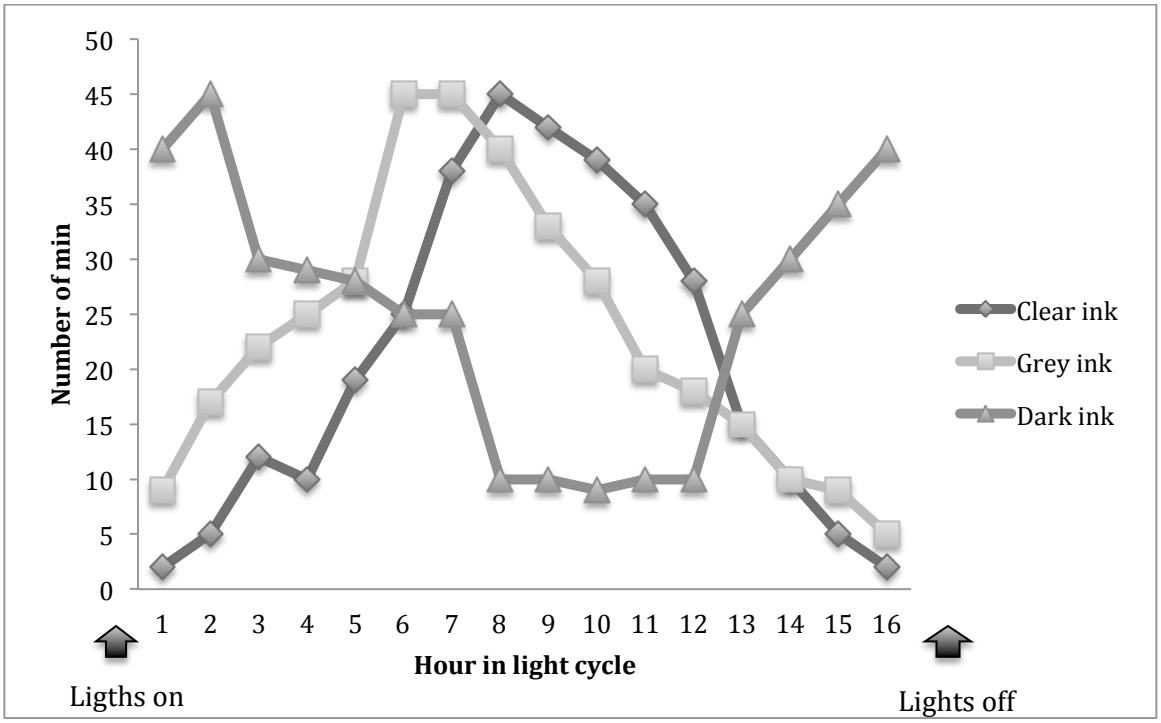
3) What is one weakness of the experimental design? Explain. (5 pts)

4) Describe one other study that has tested a similar hypothesis in another species. Are the results of that study and the present study consistent? Explain. (5 pts)

5) Describe one follow up study to further test this hypothesis (a study not described in lecture or textbook). Include control groups and predictions. Use your creativity and critical thinking skills. (6 pts)

Unit #4

A group of scientists have hypothesized that birds have extra-retinal photoreceptors which play an important role in the sleep-wake cycles in birds, which would affect what time songbirds would sing. The researchers tested to see if the extra-retinal photoreceptors were located on the top of the bird's head and if blocking these receptors would affect when during the sleep-wake cycle birds would sing. To these this the researches took male birds and anaesthetized them to preform an injection under the scalp of the birds insuring not to block the bird's vision. Three colors of ink were injected in each bird in the following order: first a clear ink was injected, second a grey translucent ink and finally a dark ink was injected. After each injection birds were subjected to a long photoperiods (16L:8D) for one day and when singing occurred was recorded during the light period as number of minutes per hour. Between each ink injection birds were placed in a 12L:12D photoperiod for 3 days.



1) What are the main conclusions from this experiment, in relation to the hypothesis? Explain

2) What is one strength of the experimental design? Explain. (5 pts)

3) What is one weakness of the experimental design? Explain. (5 pts)

4) Describe one other study that has tested a similar hypothesis. Are the results of that study and the present study consistent? Explain. (5 pts)

5) Describe one follow up study to further test this hypothesis (a study not described in lecture or textbook). Include control groups and predictions. Use your creativity and critical thinking skills. (6 pts)

Unit #5

Hau et al. (2000) tested the hypothesis that testosterone increases aggressive behavior during a territorial interaction. They subcutaneously implanted spotted antbirds (an avian species in Panama) with empty or testosterone-filled implants, and then measured several aggressive behaviors: songs, snarls (vocalization), patch latency (latency to show a white patch of feathers on the back), hops, and chips (vocalization). Read the text and figure taken from this study before answering the questions below.

> …15 males were caught in the nonbreeding season (between November 10 and 20) and housed individually in captivity. The first 7 birds that were captured were places in the T-implant group (7 males) while the next 8 birds that were captured were placed in the control group (8 males). All birds received either one empty implant or one T-filled implant under the skin. After 3-10 days, to measure the aggression of birds, we conducted staged encounters (15 minutes each) between two males in the morning hours (6:30 a.m. until 11:30 a.m.). Birds were tested in their home cages, whereby two males were placed at 30 cm distance facing each other. Each T-implanted male was tested against a control male. Birds had auditory but not visual contact with their opponents before the staged encounter. During the staged encounter, the two opponents were visually isolated from the other birds….

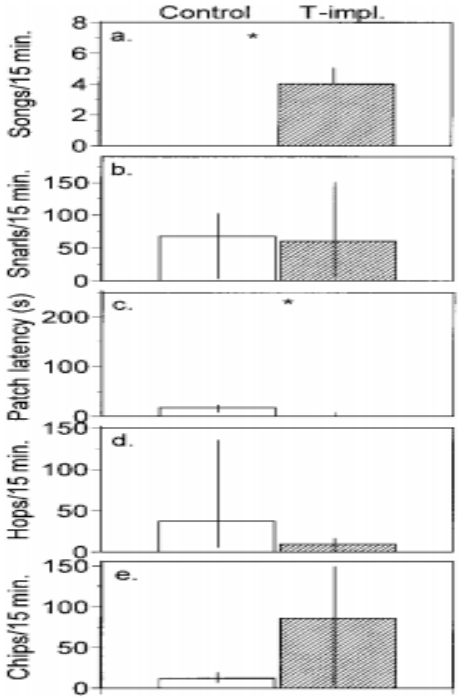


FIG. 2. Behavioral responses of control (open bars, $n = 8$) and T-implanted (hatched bars, $n = 7$) male Spotted antbirds during 15 min of a staged male–male encounter experiment (medians ± quartiles). (a) Songs; (b) snarls; (c) latency to expose the white back patch; (d) hops away from the opponent; (e) chips. Scale of y-axis is matched to that of Fig. 4 to facilitate comparison. * Indicates a significant difference between groups, $P < 0.05$.

a. What are the main conclusions from this experiment, in relation to the hypothesis? Explain.

b. What is one strength of the experimental design? Explain.

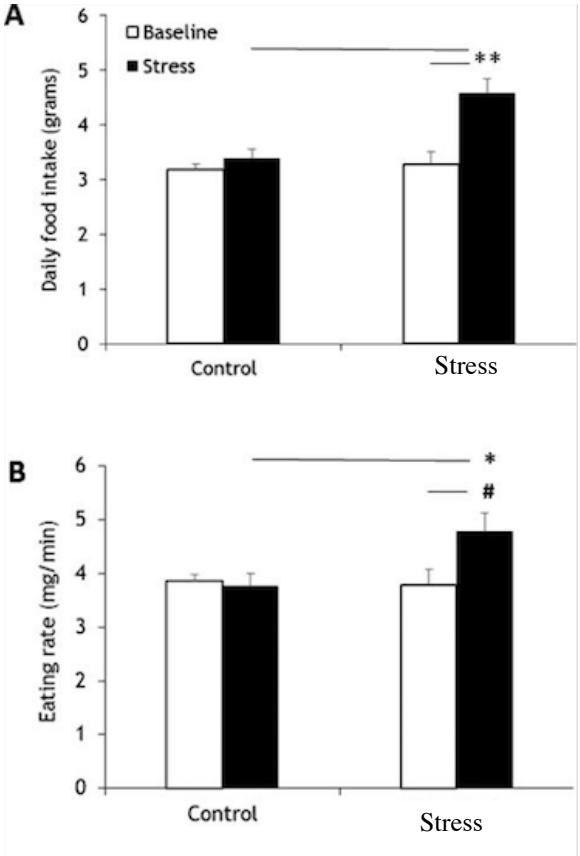
c. What is one weakness/limitation of the experimental design? Explain.

d. Describe one other study that has tested this hypothesis (**discussed in lecture or in textbook**). Are the results of the two studies consistent? Explain.

e. Describe one follow up study to further test this hypothesis in spotted antbirds (a study **not** described in lecture or in textbook). Include control groups and predictions. Use your creativity!

Unit #6

Scientist hypothesized that stress has a relationship to feeding behavior, by increasing food intake in relation to stress. To test this hypothesis, mice were subjected to one of two conditions: condition one is a chronic stress, where a mouse is exposed to the cat urine for 4 hours a day, condition two was a control group (no urine). Before testing began, a baseline rate of feeding was measured for 3 days. In the experimental condition, animals were removed from their home cage and placed in a new cage in the testing room, which was the same as the home cage except for clean bedding and cat urine sprayed on the bedding. Experimental animals were left in the cage with the cat urine for 4 hours starting at 8:00am each morning and ending at 12:00pm, then placed back into their home cage and placed back in to the original colony room with the rest of the mice. Once placed back into the colony room, food consumption by both groups of mice was measured taking into account feeding rate and daily food intake. Use the figure below to taken answer the questions.



Groups: Control and Experimental group (stress). Data represent group averages ± SEM. Control: N=7; Subordinate: N=5. # p=0.055, *p<0.05, ** p<0.01.

1) What are the main conclusions from this experiment, in relation to the hypothesis? Explain

2) What is one strength of the experimental design? Explain. (5 pts)

3) What is one weakness of the experimental design? Explain. (5 pts)

4) Describe one other study that has tested this hypothesis. Are the results of that study and the present study consistent? Explain. (5 pts)

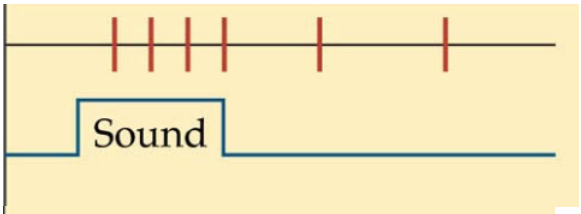
5) Describe one follow up study to further test this hypothesis (a study not described in lecture or textbook). Include control groups and predictions. Use your creativity and critical thinking skills. (6 pts)

Graph adapted from Razzoli, Sanghez, Bartolomucci 2015.

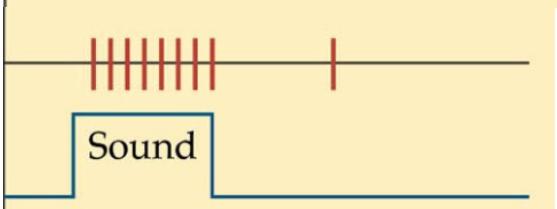
Sample Multiple Choice Questions

1) Moths are known to have ears that are tuned to bat sounds. When a hunting bat is nearby, moths are known to go into a dive. Which of the following shows an action potential pattern that would be related to a moth dive:

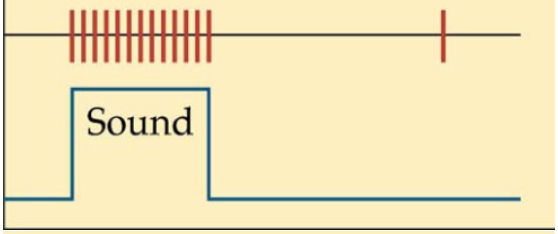
a.



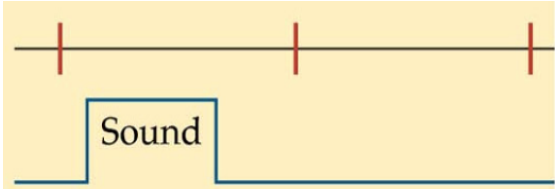
b.



c.



d.



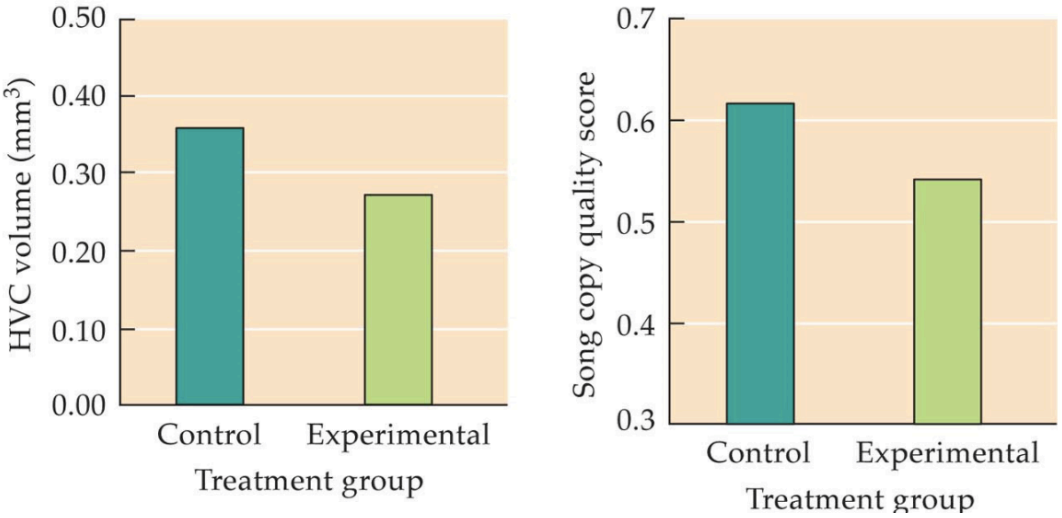
e.

2) In the experiment with male white-throated sparrows, males were removed from their territories. In some territories, taped songs were played from a speaker. Which is the best control?
   a. Speaker playing nothing (silence)
   b. Speaker playing white noise
   c. Speaker playing hip hop
   d. Stuffed birds playing white-throated sparrow songs
   e. No control required

3) What 3 conditions must be met for evolution by natural selection to occur?

a. Adaptation, Modification, Stress
b. Variation, Heredity, Differences in reproductive success
c. Reproductive stress, environmental change, Adaption
d. Variation, Environmental change, stress
e. Change in morphology, Stress, Heredity

4) The following graph demonstrates the results from an experiment on the effects of early life nutritional stress on swamp sparrows. Which of the following conclusions best characterizes the results specifically shown below?



a. Early life nutritional stress has no effect on song learning
b. Early life nutritional stress has no effect on brain areas involved in song learning
c. Animals that received early life nutritional stress were the same as controls
d. Both brain structures and song learning were affected by early life nutritional stress
e. Early life experiences increase stress hormones

5) Lorenz and Tinbergen proposed that a simple stimulus could activate complex stereotyped behavior. One example given was in gulls where parents have a red dot on the bill, which chicks pack at, and this enlists a feeding response from the gull parents. What are the names for each of the stages in the stereotyped behavior:

    a. Sign stimulus, Action, Output
    b. Sign stimulus, Innate releasing mechanism, Fixed action pattern
    c. Visual input, Behavioral action, Innate releasing mechanism
    d. Supernormal stimulus, Innate mechanism, Releasing mechanism
    e. Innate releasing mechanism, Supernormal stimulus, Fixed action pattern

6) When the gene for oxytocin is knocked out in male mice, these subjects show impaired social memory comparable to social amnesia. The best control group would be:
    a. Male mice without any genes changed
    b. Oxytocin gene knockout mice given oxytocin
    c. Female mice with oxytocin gene knocked out
    d. Male mice with oxytocin receptors blocked
    e. No controls are needed

7) In Marler's experiment with WCSP in which eggs were removed from the nests and raised in soundproof chamber and birds were shown to sing isolate songs what about the proximate mechanisms can be taken from this study.
    a. Dialects are product of heredity
    b. Dialects are products of environmental variables
    c. Both a and b
    d. Neither because heredity and environmental variable can not be separated from this experiment
    e. That dialects come from parental care