FRQ Friday #1

2017 #1

TABLE 1. EFFECT OF 0.1 mM CAFFEINE ON MEMORY IN BEES

Treatment	Memory (average probability of revisiting a nectar source $\pm 2SE_{\bar{X}}$)	
	10 Minutes	24 Hours
Control	0.72 ± 0.09	0.41 ± 0.07
Caffeine	0.83 ± 0.07	0.78 ± 0.08

. In flowering plants, pollination is a process that leads to the fertilization of an egg and the production of seeds. Some flowers attract pollinators, such as bees, using visual and chemical cues. When a bee visits a flower, in addition to transferring pollen, the bee can take nectar from the flower and use it to make honey for the colony.

Nectar contains sugar, but certain plants also produce caffeine in the nectar. Caffeine is a bitter-tasting compound that can be toxic to insects at high concentrations. To investigate the role of caffeine in nectar, a group of researchers studied the effect of 0.1 mM caffeine on bee behavior. The results of an experiment to test the effect of caffeine on bees' memory of a nectar source are shown in Table 1.

FRQ Friday #1

2017 #1

(a) On the axes provided, **construct** an appropriately labeled graph to illustrate the effect of caffeine on the probability of bees revisiting a nectar source (memory).

(b) Based on the results, **describe** the effect of caffeine on each of the following:

- Short-term (10 minute) memory of a nectar source
- Long-term (24 hour) memory of a nectar source

(c) **Design an experiment** using artificial flowers to investigate potential negative effects of increasing caffeine concentrations in nectar on the number of floral visits by bees. **Identify** the null hypothesis, an appropriate control treatment, and the predicted results that could be used to reject the null hypothesis.

(d) Researchers found that nectar with caffeine tends to have a lower sugar content than nectar without caffeine. Plants use less energy to produce the caffeine in nectar than they do to produce the sugar in nectar. **Propose ONE benefit** to plants that produce nectar with caffeine and a lower sugar content. **Propose ONE cost** to bees that visit the flowers of plants that produce nectar with caffeine and a lower sugar content.

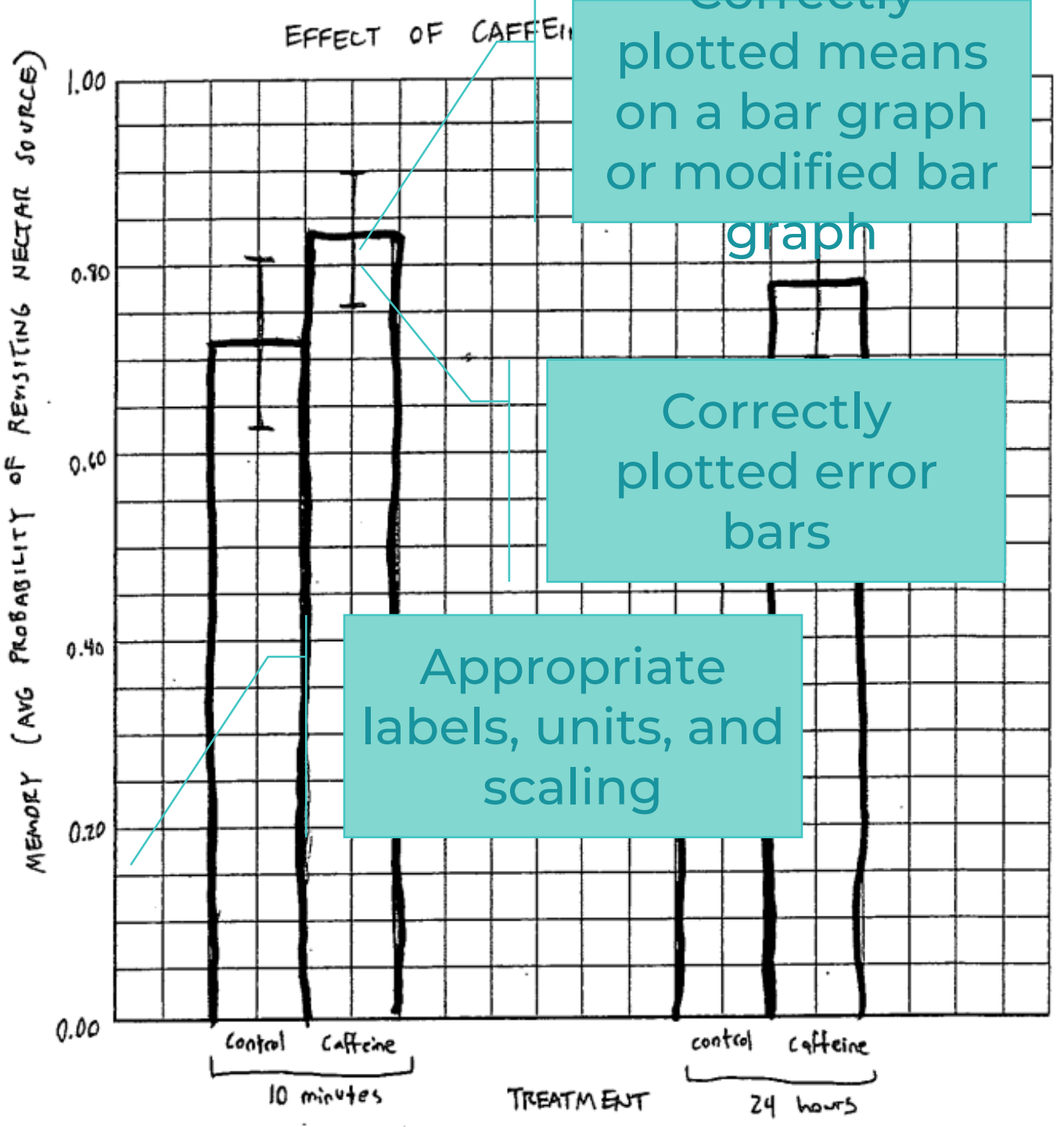
FRQ Friday #1

(a) On the axes provided, **construct** an appro
probability of bees revisiting a nectar sourc

Construct graph (3 points)

- Correctly plotted means on a bar g
- Appropriate labels, units, and scal
- Correctly plotted error bars

Treatment	Memory (average probability of revisiting a nectar source $\pm 2SE_{\bar{x}}$)	
	10 Minutes	24 Hours
Control	0.72 ± 0.09	0.41 ± 0.07
Caffeine	0.83 ± 0.07	0.78 ± 0.08



Correctly plotted means on a bar graph or modified bar graph

Correctly plotted error bars

Appropriate labels, units, and scaling

FRQ Friday #1

2017 #1

(b) Based on the results, **describe** the effect of caffeine on each of the following: **(2 points)**

- Short-term (10 minute) memory of a nectar source
- Long-term (24 hour) memory of a nectar source

Description (2 points)

Short-term	Caffeine does not affect short-term memory/memory at 10 minutes.
Long-term	Caffeine improves/increases the long-term memory/memory at 24 hours.

B) On a short term (10 minute) scale, caffeine has no significant effect on the bees' memory of nectar source. The standard deviation of the control and the experimental (caffeine) group overlapped.

On a long term (24 hours) scale, caffeine improves significantly bees' memory of the nectar source.

According to the data, the bees who consumed nectar with caffeine were almost twice more

FRQ Friday #1

2017 #1

(c) **Design an experiment** using artificial flowers to investigate potential negative effects of increasing caffeine concentrations in nectar on the number of floral visits by bees. **Identify** the null hypothesis, an appropriate control treatment, and the predicted results that could be used to reject the null hypothesis. **(3 points)**

Identification (3 points; 1 point per row)

Null hypothesis	Increasing caffeine concentration has no effect (on the number of floral visits by bees).
Control	(Nectar/flowers with) no caffeine
Predicted results	• The number of floral visits by bees is different at increasing caffeine concentrations. • The number of floral visits by bees is different than the control.

FRQ Friday #1

2017 #1

Identification (3 points; 1 point per row)

Null hypothesis	Increasing caffeine concentration has no effect (on the number of floral visits by bees).
Control	(Nectar/flowers with) no caffeine
Predicted results	• The number of floral visits by bees is different at increasing caffeine concentrations. • The number of floral visits by bees is different than the control.

c) A null hypothesis would be that varying caffeine concentrations in nectar will have no effect on floral visits by bees. Observed data will not differ significantly from this expected results.

In my ~~experimental group~~ experiment, the independent variable being controlled is the caffeine concentration in nectar. There will be nine experimental groups ranging from 0.1 M to 0.9 M

FRQ Friday #1

2017 #1

1A2

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

This will be prepared with artificial flowers and careful measuring out of nectar solutions in them.

incrementally. Then there will be one control group without any caffeine. The dependent variable will be the number of floral visits by bees over a 24-hour time period. This will be recorded by camera footage and analyzed by computer software. The number of bees and type of flower and amount of nectar solution will be kept constant for each group. The experiment will be repeated ~~six~~ ten times. Predicted results would be that the greatest concentration solution (0.9 M caffeine) will yield a drastically ~~less~~ lower number of ~~flo~~ floral visits by bees than the control solution (no caffeine). This would yield a X^2 value large enough to reject the null hypothesis.

FRQ Friday #1

2017 #1

(d) Researchers found that nectar with caffeine tends to have a lower sugar content than nectar without caffeine. Plants use less energy to produce the caffeine in nectar than they do to produce the sugar in nectar. **Propose ONE benefit** to plants that produce nectar with caffeine and a lower sugar content. **Propose ONE cost** to bees that visit the flowers of plants that produce nectar with caffeine and a lower sugar content. **(2 points)**

Proposed plant benefit (1 point)

- More pollen is transferred/more visits by pollinators.
- Plants store energy/have more energy available for other uses.

Proposed bee cost (1 point)

- (Individual) bees visit more flowers.
- (Individual) bees use more energy.
- The colony/bees may produce less honey
- The colony/bees may produce lower quality honey/honey that provides less energy.

Proposed plant benefit (1 point)

- More pollen is transferred/more visits by pollinators.
- Plants store energy/have more energy available for other uses.

Proposed bee cost (1 point)

- (Individual) bees visit more flowers.
- (Individual) bees use more energy.
- The colony/bees may produce less honey
- The colony/bees may produce lower quality honey/honey that provides less energy.

D) Plants with higher caffeine content and lower sugar content in their nectar benefit since they use less energy in metabolic processes. Less sugar production requires lesser energy. They are more efficient, and can use saved energy to support other aspects that will improve survival/reproductive rates. On the flip side, bees who consume the nectar of such plants are obtaining less sugar per visit. Since flying around visiting plants uses energy, these bees are less efficient in obtaining energy. They get the short end of the stick. Lower efficiency means lower rates of reproductive/survival success.