AP® STATISTICS
2007 SCORING GUIDELINES

Question 2

Intent of Question

The three primary goals of this question are to assess a student's ability to: (1) clearly explain the importance of a control group in the context of an experiment; (2) describe the randomization process required for three groups; and (3) reduce variability by grouping experimental units as homogeneously as possible.

Solution

Part (a):

A control group gives the researchers a comparison group to be used to evaluate the effectiveness of the treatments. The control group allows the impact of the normal aging process on joint and hip health to be measured with appropriate response variables. The effects of glucosamine and chondroitin can be assessed by comparing the responses for these two treatment groups with those for the control group.

Part (b):

Each dog will be assigned a unique random number, 001–300, using a random number generator on a calculator, statistical software, or a random number table. The numbers will be sorted from smallest to largest. The dogs assigned the first 100 numbers in the ordered list will receive glucosamine. The dogs with the next 100 numbers in the ordered list will be assigned to the control group. Finally, the dogs with the numbers 201–300 will receive chondroitin.

Part (c):

The key question is which variable has the strongest association with joint and hip health. The goal of blocking is to create groups of homogeneous experimental units. It is reasonable to assume that most clinics will see all kinds and breeds of dogs so there is no reason to suspect that joint and hip health will be strongly associated with a clinic. On the other hand, different breeds of dogs tend to come in different sizes. The size of a dog is associated with joint and hip health, so it would be better to form homogeneous groups of dogs by blocking on breed.

Scoring

Parts (a), (b), and (c) are scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as essentially correct (E) if an advantage of using a comparison group is described in the context of this study.

Part (a) is scored as partially correct (P) if an advantage of using a control group is described but not in the context of this study.

Part (a) is scored as incorrect (I) if the student says that control groups should always be used but gives no further explanation *OR* an incorrect explanation.

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Question 2 (continued)

Note: Since "treatment" and "control" are standard terms in design, a comparison of specific aspects of the study is needed to establish context.

Part (b) is scored as essentially correct (E) if randomization is used correctly, and the method of randomization can be implemented after reading the student response (so that two knowledgeable statistics users would use the same method to assign dogs to treatment groups).

Part (b) is scored as partially correct (P) if randomization or chance is used, but the method could not be implemented after reading the student response.

Part (b) is scored as incorrect (I) if randomization or chance is not used in a planned way *OR* the solution does not yield a completely randomized design.

Part (c) is scored as essentially correct (E) if:

the student argues that the variable with the stronger relationship to joint and hip health should be used as the blocking variable;

OR

the student states that the variable with the larger anticipated variability in the response measure should be used as the blocking variable so that units within blocks are as homogeneous as possible. A rationale is required, but a variable does not have to be selected.

Part (c) is scored as partially correct (P) if:

the student indicates that the purpose of blocking is to create groups of homogeneous experimental units but makes an error in the application to this experiment;

OR

the student does not acknowledge that there may be more variability associated in the response variable with one of the variables (breed or clinic) than the other;

OR

the student does not recognize that both variables are associated with variation in the response variable.

Part (c) is scored as incorrect (I) if the student does not exhibit an understanding of the purpose of blocking.

4 Complete Response

All three parts essentially correct

3 Substantial Response

Two parts essentially correct and one part partially correct

2 Developing Response

Two parts essentially correct and no parts partially correct

OR

One part essentially correct and two parts partially correct

OR

Three parts partially correct

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Question 2 (continued)

1 Minimal Response

One part essentially correct and either zero or one part partially correct

OR

No parts essentially correct and two parts partially correct

2. As dogs age, diminished joint and hip health may lead to joint pain and thus reduce a dog's activity level. Such a reduction in activity can lead to other health concerns such as weight gain and lethargy due to lack of exercise. A study is to be conducted to see which of two dietary supplements, glucosamine or chondroitin, is more effective in promoting joint and hip health and reducing the onset of canine osteoarthritis. Researchers will randomly select a total of 300 dogs from ten different large veterinary practices around the country. All of the dogs are more than 6 years old, and their owners have given consent to participate in the study. Changes in joint and hip health will be evaluated after 6 months of treatment.

(a) What would be an advantage to adding a control group in the design of this study?

The advantage to adding a control group in the design of this study would be to have something to compare the results to. This helps to reduce the effects of confounding variables. For example the weather which can affect joint pain.

(b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.

To obtain a compleatly randomized design I would number each dog 1 to 300 and then using a random number generator I would select 100 numbers ignoring repeats the 100 dogs corresponding to those 100 numbers will be placed in the first treatment group and will recieve glucosamine. I will repeat this process selecting 100 new numbers, these 100 dogs will be placed in the second treatment group and will recieve chondroitin and the remaining 100 dogs will be the control group and will recieve a placeb.

(c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which one of these two variables to use as a blocking variable?

Whichever variable has more variation should be used as a block. I think breed of dog will cause more variation in the experiment because different kinds of dogs can respond differently to the treatment, but which clinic the dogs come from probably will have less effect on the experiment.

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2. As dogs age, diminished joint and hip health may lead to joint pain and thus reduce a dog's activity level. Such a reduction in activity can lead to other health concerns such as weight gain and lethargy due to lack of exercise. A study is to be conducted to see which of two dietary supplements, glucosamine or chondroitin, is more effective in promoting joint and hip health and reducing the onset of canine osteoarthritis. Researchers will randomly select a total of 300 dogs from ten different large veterinary practices around the country. All of the dogs are more than 6 years old, and their owners have given consent to participate in the study. Changes in joint and hip health will be evaluated after 6 months of treatment.

(a) What would be an advantage to adding a control group in the design of this study?

It would be an advantage to add a control group to this study because then after 6 months, you have a group to compare with the treated dogs in the study, to see if the treatments really had an impact in promoting joint and hip health and reducing the onset of canine osteoarthritis.

(b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.

For a completely randomized design, I would assign each of the 300 dogs a number, 1-300, and then put all the numbers into a hat. Then draw 100 numbers out of the hat and assign them to group 1, the control group. Then pull out 100 more numbers and assign them to group 2, the glucosamine treatment. Then with the 100 left over dogs assign them to group 3, for the chondroitin treatment. That way, you will have three groups for a completely randomized design.

(c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which <u>one</u> of these two variables to use as a blocking variable?

Rather than using a completely randomized design, I would encorporate blocking on the specific breed of dog, because the different treatments could possibly have a different effect on the different types of dogs, therefore I would use the blocking on breed of dog so it would eliminate any variables that could change the actual data. I would rather block on breed of dog than clinic, because breeds of dogs seem to be much more different than different clinics, therefore I would block on breeds of dogs.

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2. As dogs age, diminished joint and hip health may lead to joint pain and thus reduce a dog's activity level. Such a reduction in activity can lead to other health concerns such as weight gain and lethargy due to lack of exercise. A study is to be conducted to see which of two dietary supplements, glucosamine or chondroitin, is more effective in promoting joint and hip health and reducing the onset of canine osteoarthritis. Researchers will randomly select a total of 300 dogs from ten different large veterinary practices around the country. All of the dogs are more than 6 years old, and their owners have given consent to participate in the study. Changes in joint and hip health will be evaluated after 6 months of treatment.

(a) What would be an advantage to adding a control group in the design of this study?

An advantage to adding a control group to this design would be that it gives the experiment something to compare its results to, to see how much of a difference the treatments make.

(b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.

For every dog that is chosen roll a die. IF the die is a 1 or 2 give the dog the glucosamine. IF the die is a 3 or 4 give the dog the chondroitin. IF the die is a 5 or 6 put the dog in the control group. This will completely randomize the design.

(c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which <u>one</u> of these two variables to use as a blocking variable?

I would decide to use the blocking on breed of dog. The clinic the dog is in should not affect the medicine the dog is given. However, different breeds of dogs might respond to the medicines differently. Therefore, the blocking on breed of dog should be used.

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AP® STATISTICS
2007 SCORING COMMENTARY

Question 2

Overview

The three primary objectives of this question were to evaluate students' abilities to: (1) clearly explain the importance of a control group in the context of an experiment; (2) describe the randomization process required for three groups; and (3) reduce variability by grouping experimental units as homogeneously as possible.

Sample: 2A
Score: 4

The advantage of a control group for comparison with the results for the dietary supplements is given in part (a). In particular, the response indicates that the control group provides this comparison over the same time period with the same conditions, one example being the weather. A detailed randomization procedure that uses a random number generator for placing 100 dogs in the glucosamine group, 100 dogs in the chondroitin group, and 100 dogs in the control group is described in part (b). In part (c) the choice of the blocking variable is linked to the reduction in variability, and the response recommends breed as the blocking variable since breed is believed to have more variation than clinic.

Sample: 2B
Score: 3

In part (a) the response correctly describes the comparative advantage of a control group in the context of treatments to improve joint and hip health. Specifically, it states "you have a group to compare with the treated dogs in the study, to see if the treatments really had an impact." In part (b) the response provides a detailed description of assigning numbers to the 300 dogs and then drawing the dogs' numbers from a hat to form the three groups. In part (c) the response discusses the relationship between different breeds and different treatments (rather than the desired response variable, joint and hip health) and states that "breeds of dogs seem to be much more different than different clinics," which justifies the choice of blocking on breed. However, the response incorrectly states that blocking "would eliminate any variables that could change the actual data."

Sample: 2C
Score: 2

The comparative advantage of a control group in a design is given in part (a), which could apply to any design which has a control group. Hence, the context for this study is not established in this response. The randomization plan is to roll a die for each dog. The dog is assigned to the glucosamine group if a 1 or 2 appears, the chondroitin group if a 3 or 4 appears, and the control group if a 5 or 6 appears. This randomization will yield a completely randomized design with unequal (in most cases) sample sizes for the treatments. In part (c) blocking on breed is justified by a significant relationship to the response variable, and hence, a reduction in variability is achieved by blocking on breed. The more significant relationship is not established for breeds in comparison to clinics since the discussion of clinics is focused on the clinic not affecting the medicines.