SYMSYS 130: Research Methods in the Cognitive and Information Sciences (Spring 2013)

Homework #3- Instructor's Responses (6/5/2013)

Please respond to the following questions with short essays (300-500 words, not more). Answers will be scored out of 25 points total, based on the following criteria (5 pts each):

- informativeness (interesting, nonobvious),
- correctness (sound, accurate),
- thoroughness (convincing, rigorous),
- coherence (consistent, well constructed), and
- conciseness (clear, succinct).

1. Cognitive psychologists sometimes use "response times" or "reaction times" as a dependent variable in experiments designed to test how knowledge is represented in the mind or brain, and/or how strongly two concepts are associated. For example, reaction times have been used to test whether memory for concepts is organized hierarchically (e.g. cat is a mammal, mammal is an animal) or associationally (e.g. cat is associated strongly with dog and mouse, but weakly with vertebrate and neighborhood). When participants take less time to respond to a question about two concepts, this is taken as an indication that the concepts are close together in memory, e.g. in a hierarchical tree or an association network. Assuming a sample from a class at Stanford, design a reaction time experiment to test whether concept memory is stored hierarchically or associationally for two types of objects: natural objects and artificial objects. Identify the group or groups (is it within or between groups?) in your experiment, how participants are assigned, the conditions, factors, and measures. What could be the main effects and what could be an interaction effect? Justify your design choices.

Participants will be asked to judge whether sentences "are true or false most of the time", e.g. "A cat is a mammal" (natural objects-hierarchical relationship), "A cat eats mice" (natural-associational), "A car is a vehicle¨ (artificial-hierarchical) , and "A car uses gasoline" (artificial-associational). True sentences will be interspersed with an equal number of false sentences, as judged by independent observers, e.g. "A cat is a plant" is a false sentence. The measure is the P's reaction time for each true sentence: the time elapsed from presentation of the sentence up to pressing the T key when that is the correct answer. An incorrect response will generate a "Try again" message, with the total reaction time from presentation being recorded up to the time when the P presses the correct key. True sentences will be generated based on independent survey takers' most popular nominated examples of natural and artificial objects, and subsequently their responses to questions such as "A cat is a member of what category?" and "A car is associated with what concept?" in order to guard against the experimenters generating examples that favor a given hypothesis. All participants would be assigned to one condition, with randomized presentation of the sentences, so this is a within-group design. The factors are (a) Artificial versus Natural and (b) Hierarchically Related versus Associationally Related.

Reaction time in this experiment is taken as a measure of how close together two concepts are in memory (e.g. Cat and Mammal, or Cat and Mice). A main effect would be a consistent advantage for either factor, e.g. if true hierarchical sentences are responded to more quickly than associational ones and by the same amount for both artificial and natural objects, that would be a main effect favoring hierarchical storage. If true sentences about artificial objects

are responded to more quickly and by the same amount for both hierarchical and associational sentences, that would indicate a main effect favoring closer connections between artificial objects than between natural ones, but it would be hard to conclude that this is general to the two types of objects rather than being an artifact (no pun intended) of the experimental design, i.e. this pattern could reflect a bias in the nomination of objects and their related categories and concepts by the third party participants who generate these examples. If the ordering of relative average reaction times between categorically and associationally related concepts differs for natural and artificial objects, this would be an example of an interaction effect, e.g. we might find that for artificial objects, true categorical statements are recognized more quickly than associational ones, while for natural objects the reverse is true.

2. A researcher is investigating the effect of annual income on attendance at religious services. Specifically, the researcher hypothesizes that wealthier people on average attend services more sparsely during the year, e.g. on major religious holidays but not every week, whereas less wealthy people attend more regularly. Design an *unobtrusive* observational study to test this hypothesis.

A good proxy for wealth, I postulate, is the value of one's car. This could be researched independently, but I think most people would agree that an expensive car is much more likely to be owned by a high income person than by a low income person. If we go to the parking lots outside of religious services at multiple locations, across a mix of low and high income surounding neighborhoods, we could record the Blue Book value of each car in the parking lots of these places of worship during services, separating the services into those held on major religious holidays for that congregation versus nonholidays. If the hypothesis is true, we should find, that there is a significantly higher correlation between the number of high value cars in the parking lot and the presence of a religious holiday during the service than there is between the number of low value cars and the presence of a religious holiday during the service.

3. Consider the following experiment: Three randomly assigned groups from a sample are asked to estimate how old George Clooney is. The two treatment groups are each given an anchor question prior to providing their estimate, either “Is Clooney older or younger than 45? State whether he is older or younger” or “Is Clooney older or younger than 55? State whether he is older or younger”. The control condition is not given an anchor question prior to estimating Clooney's age. The experiment is designed to test whether the presence of an anchor value influences participants' estimates up or down. Write down a regression equation for this experiment and explain each variable or coefficient.

The regression equation is

$y_i = \beta_0 + \beta_1 x_i + \beta_2 z_i + \varepsilon_i$

where

i = the index of the participant (a number from 1 through N, the total number of particpants)
y_i = participant i's estimate of Clooney's age
β_0 = the coefficient for the control group
β_1 = the coefficient for the low-anchor group
x_i = an indicator variable that is 1 in the 45 anchor condition and 0 otherwise

β_2 = the coefficient for the high-anchor group
z_i = an indicator variable that is 1 in the 55 anchor condition and 0 otherwise
ε_i = the residual error term for participant i.

4. How could your model from question 3 be turned into a simulation?

From the slides (5/15/2013), a simulation is “A computational process in which a model is used to generate outputs from specific inputs (or outcomes from initial conditions)”. It may be nondeterministic, in which inputs are generated randomly. In the case of the model for question 3, the only random part is the residual error term ε_i. A model built from data from an experiment with people could be used to estimate a distribution for the ε_i's, e.g. the mean squared error $MSE=\sum_{i\epsilon[1,N]} (\hat{y}-y_i)^2/N$ can be used as the variance of a normal distribution of mean 0 from which random values of ε_i are generated for our simulation. For the simulation, we create three groups of mock agents corresponding to the three conditions in the experiment of question 3: control, low anchor, and high anchor. We can simulate an actual subject pool for any number of mock participants/agents, as follows.

Control group of L agents indexed by i: $y_i = \beta_0 + \varepsilon_i$
Low anchor group of M agents indexed by j: $y_j = \beta_0 + \beta_1 x_j + \varepsilon_j$
High anchor group of N agents indexed by k: $y_k = \beta_0 + \beta_2 z_k + \varepsilon_k$

The simulation would produce a list of L, M, and N responses corresponding to the control, low anchor, and high anchor agents in the simulation.