Written Report
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Team CROC
Isaac Crofts
Niamh Evenhouse
Kitu Komya
Ignat Kulinka

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a) **Investigative question:** What are the effects and interactional effects of sitting with different pets (cat, dog, or crocodile, each for 10 minutes) and experiencing different types of memories (happy or sad, each for 1 minute) on blood oxytocin in pg/mL?

b) **Experiment design:** We used a completely randomized 2 x 3 factorial design with blocking. Our response variable was calculating the change in blood oxytocin in pg/mL before and after each treatment. Our factors were sitting with a pet for 10 minutes (3 levels: cat, dog, crocodile) and experiencing memories (2 levels: happy, sad). Our nuisance factor was gender, which we controlled for by blocking. We chose to block by gender because it's scientifically known that women and men have different baseline oxytocin levels, with women having a higher level. We randomized sampling, treatment assignment, and treatment order. Some uncontrolled variables included subject's location, wealth, marriage, etc, which were all controlled for by randomizing sampling and assignment to prevent influence.

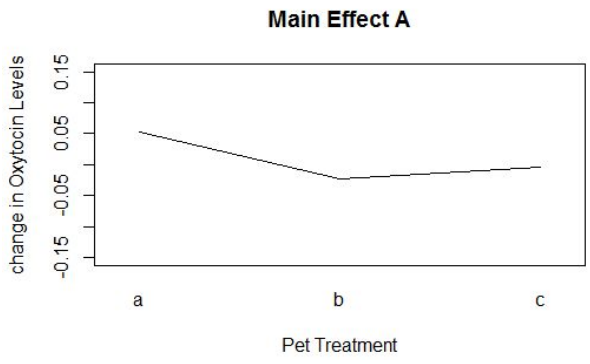
c) **Sampling method:** Each household on the Islands has a five-digit phone number, which consists of a two-digit area code and three-digit extension. We used R function *sample()* to randomly generate five-digit numbers, excluded all numbers whose area code did not exist, and then called each number. If the number was connected, and the person who answered gave consent to a group member, the person was included in our sample. Using this sampling method, every household was equally likely to be called regardless of town size. This also means that people living in larger households were slightly less likely to be included in the sample. Despite this shortcoming, we consider the method random enough not to affect the validity of our results. Our sample size, justified in part (e), was 96.
Description of how the design was carried out: During our phone conversations, we recorded the subject's name and address. We then visited the subject to obtain consent. We created a vector of all treatment combinations for each block and used the *sample()* command without replacement to assign treatment combinations to participants. To carry out the treatment, we divided participants among group members. Each member measured their subjects' blood oxytocin level, applied the first treatment followed almost immediately by the second treatment, and measured the blood oxytocin level again immediately the second treatment ended. By using a shared protocol we obtained consistency in our measurement.

d) **Why this design is appropriate:** This design is appropriate because we are interested in studying the effects of two factors (one with two levels and the other with three levels) and the interactions between the two factors. In addition, due to prior knowledge of differences of base levels of oxytocin levels between men and women, it is appropriate to introduce blocking by gender in our design. That is why we chose a 2 by 3 factorial design with blocking.

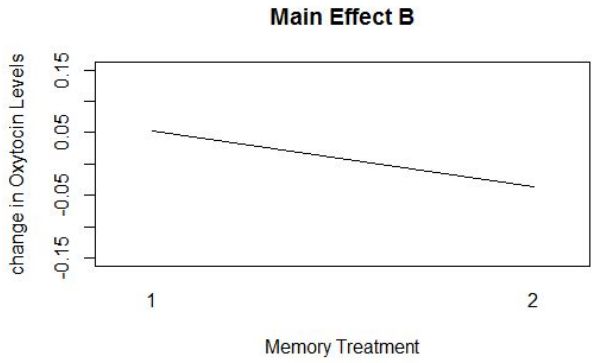
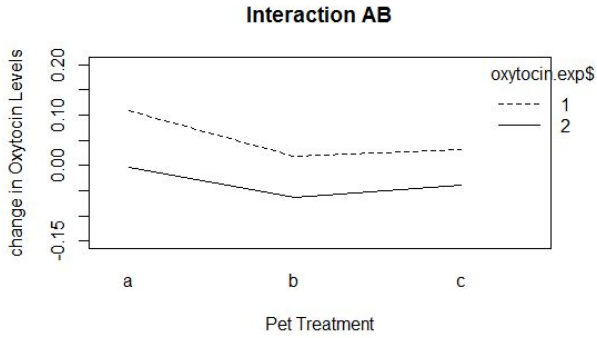
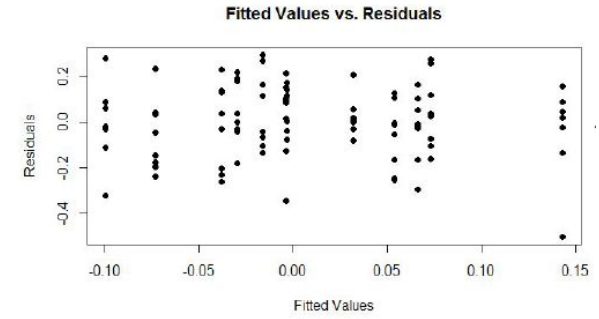
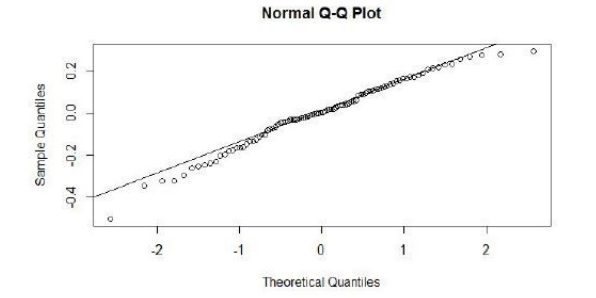
e) **Justification of sample size:** We wanted to be able to detect a relatively small difference of 0.05 pg/mL in mean change in blood oxytocin levels. When we first started to sample, we noticed that the differences between blood oxytocin levels were very small, which is why we used 0.05 pg/mL. Using the standard deviation from our initial data collection (the standard deviation was 0.05/0.35 = 0.15), this value was then converted to an effect size of 0.35. We found that in order to detect this effect with a power of at least 0.7 using $\alpha = 0.05$, we needed 16 observations in each of our 6 treatment groups, or a total sample size of 96. We performed this calculation using the R function *pwr.anova.test*.

f) **Analysis of the data:** Using the *aov* function in R, we found that the memory (treatment B) main effect was significant (p-value = 0.0101), while the pet (treatment A) main effect was not significant (p-value = 0.1675). The pet-by-memory (AB) interactional effect between these two treatments was not significant (p-value = 0.8732). Blocking by gender was statistically significant and therefore did help in reducing noise (p = .0392).

Our regression model (which only includes significant variables) is:
Δ blood oxytocin level = $0.01771 - 0.08792x_{Memory\_Sad} + 0.07000x_{Gender\_Male}$
where we see that sad memories negatively correlate with blood oxytocin level, while the male gender is positively correlated with blood oxytocin level.



Factor A (pet treatment) seems to have a small main effect. Change in blood oxytocin only varied by about 0.10 pg/mL between treatment levels a (cat) and b (dog),
and by even less between b and c (dog and crocodile) and a and c (cat and crocodile), thus confirming our findings.

	Factor B (memory treatment) seems to have a substantial main effect. Change in blood oxytocin varied by over 0.15 pg/mL between treatment levels 1 (happy) and 2 (sad), thus confirming our findings.
	The lines for A and B are close enough to parallel that we can claim that the interactional effects between happy and sad memories over the three pet treatments is negligible.
	The residual plot is patternless and shows no obvious trend and thus our assumptions of linearity and constant variance are met, affirming that our model is valid.
	The residuals follow the line quite well, and there is only slight deviation at the extrema. We can thus conclude that the errors are normally distributed and further verify that our model is valid.

Interpretation:
There are two ways to interpret results: as if we are studying a computer simulation or as if we are studying real people. If we are studying a computer simulation, we see that memories, but not pets, impact oxytocin levels. When we look at where the two factors are categorized, we see that experiencing memories is categorized as a “mental task,” while sitting with pets is categorized as “environment.” Thus, it makes sense that only experiencing memories impacted oxytocin levels since programmers would likely induce a neurochemical effect for mental tasks.

If we are studying real people, we can hypothesize that oxytocin is related to social contact and bonding, since memories impact oxytocin levels, not pets. Thus, we can deduce that these people live in a society in which positive or negative memories correlate to a social environment. And since animals do not impact oxytocin levels, perhaps this is a society in which animals are not seen as companions. Perhaps instead, these animals are used for practical functions, not for emotional support.

The fact that our blocking variable (gender) was significant indicates that oxytocin levels of men and women might change by different amounts. Studying gender differences in the delta of neurochemicals such as oxytocin would be an intriguing subject for future experiments.