J Leonard & M Shermohammed
Stats 1950 final report

PART 1: Applying new methods to explore the relationship between social measures, amygdala volume, and socioeconomic status

Data Description (same data set as midterm):

Julia Leonard collected this data set in 2012 while she was a research assistant in Dr. John Gabrieli's lab at MIT (Maheen Shermohammed was also a research assistant with Dr. Gabrieli from 2012-2014). This data includes behavioral and imaging data from 88 8th grade students who were recruited with the intention of looking at how socioeconomic status (SES) affects brain development and behavior. In this analysis, and all analyses that have come from this data set, the subjects were split into two SES groups depending on whether they received free/ reduced lunch from the government (we were fortunate enough to get government data on each kid in this study). If they received free/reduced lunch, they were categorized as low SES and if they did not, they were categorized as high SES. To give an example of what this breakdown means, students were eligible for free/ reduced lunch if their family income was below 185% of the poverty line, which approximately translates into less than $42,000 per year per family of two adults and two children. In this study, a range of brain and behavioral measures were collected, but in this analysis we will be focusing on the amygdala volume and the volume of it's respective subnuceli, as well as some social self-report and cognitive measures, specifically working memory.

Questions/Hypotheses:

The general goal of analyses for the final was to apply the new methods we learned in the second half of this course to tie up loose ends and expand on interesting findings from the midterm analyses. Here are the main questions we aimed to answer:

1. On the midterm, we never controlled for sex or even looked for sex differences in our groups. Thus, we were curious if our SES groups differed by sex.
2. On the midterm, we found a relationship between working memory and SES. Since we now know about mixed effects models, we wanted to know if this relationship still exists when controlling for the mixed effects of gender and age. Further, working memory is actually a bounded variable, so we ran a beta regression with SES to see if this more accurate model could still find this relationship.
3. For our midterm we found an interaction between working memory, opportunity of nurturance, and SES. Working memory is a bounded variable and we now know that beta regression is the more appropriate way to model this interaction, so we ran a beta regression model with opportunity of nurturance and SES predicting working memory.
4. We were curious during the midterm which social variables best predict SES groups. Now that we learned about stepwise logistic regression, we can answer this question!
5. On the midterm, we found an interaction between working memory and SES predicting right amygdala volume and right basal nuclei volume. We didn't do this correctly last time, so I wanted to go through step by step and make sure I understood this interaction and performed the correct analysis, now that we have learned about ANCOVAs.

Variables:

- Sex
- Age

Social measures:

Quantity of relationships (self report measure):

- Embedded network– how many groups of people (out of 7 domains – friends, family, church, etc) do you see on a consistent basis?
- Number of people in social network – how many people do you see on a consistent basis?
- High contact roles – How many people do you see on a consistent (at least once every two weeks) basis within each group (family, friends, church, etc).

Quality of relationship(self report measure):

- Attachment – emotional closeness from which one derives a sense of security
- Social integration – a sense of belonging to a group that shares similar interests, concerns, and recreational activities
- Opportunity of nurturance – the sense that others rely upon one for their well-being (higher = more people rely on you for their well-being)
- Reassurance of worth – recognition of one's competence, skills, and value by others
- Reliable alliance– assurance that others can be counted upon for tangible assistance
- Guidance – advice or information

Cognitive measures:

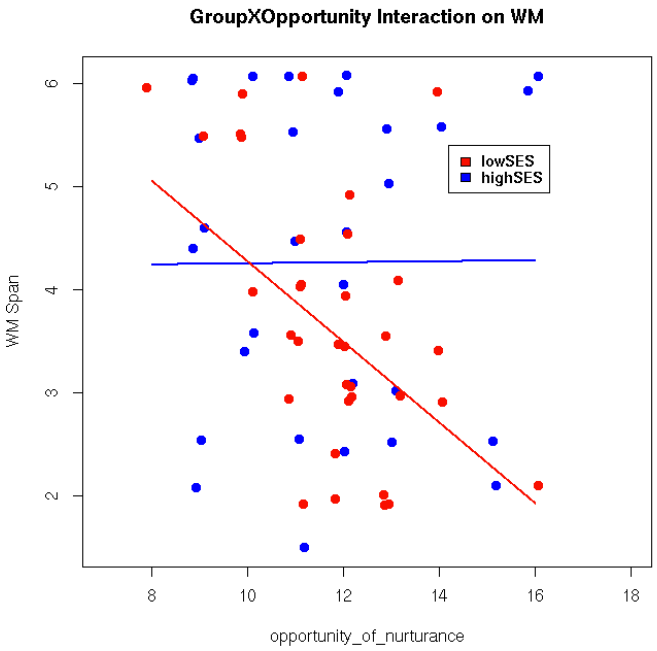
- WM_0.5 – working memory measure

Brain measures:

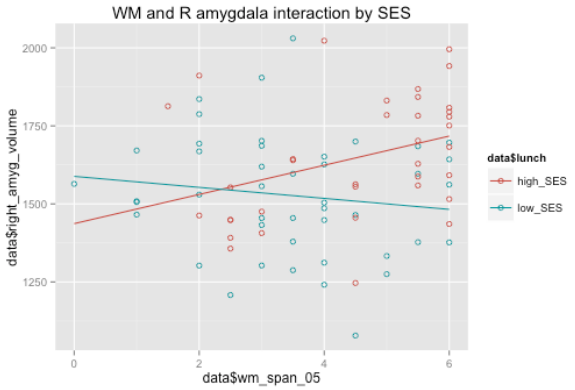
- R_amygdala_volume
- R basal nucleus
- Estimatedintracranialvolume (ICV) – need to control for intracranial volume in all

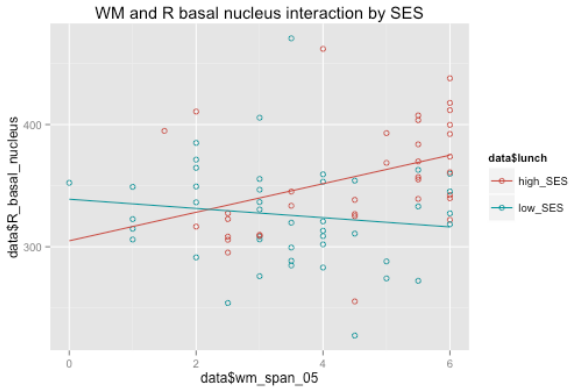
Interpretation of results:

We performed a **chi squared** test and **chi squared permutation test** on sex and SES group and found no sex differences by SES. We replicated results from the midterm and found that SES predicted working memory span. Further, we found that adding the **mixed effects** variables sex and age (two separate models) did not improve our model. Since working memory is a bounded variable, we ran a **beta regression**, further confirming the relationship between SES and working memory. Results from our midterm showed an interaction between SES and opportunity of nurturance on working memory. We found that when we included opportunity of nurturance in our model with SES, the significant relationship between SES and WM went away. We are wondering if opportunity of nurturance could function as a mediator.



We were curious which social variables best predicted SES group. We ran a **stepwise logistic regression** and found that high contact roles, embedded network, and guidance were the best predictors. Finally, on the midterm we found an interaction between working memory and SES on right amygdala volume and right basal nucleus volume, but didn't run the correct model (or go through the correct data checking steps). We ran an **ANCOVA** controlling for intracranial volume and confirmed the finding of this interaction between SES and working memory on both right amygdala volume and right basal nucleus volume.





PART 2:
Study 1: Exploring children's naïve theories of effort
Study 2: Do children rationally employ effort in response to the statistics of their environment?

Data Description

Study 1. This study explored whether children understand that domain specific effort leads to domain specific outcomes. Children were told stories about two balls (one red, one yellow) who both want to jump over a wall to get their toy on the other side. They both try to jump over and fail. One goes home to work on jumping and one goes home to work on signing. The next day they go back to the wall and the children are asked which ball they think will be able to get their toy (correct answer is the one who practiced jumping). This question is coded as 'Answer 1' in the data. The children were told another story about the two balls, this time they both want to get their toy out of a box with a heavy lid. One ball goes and works on drawing, while the other goes and works on lifting. The kids are again asked which ball they think will be able to get their toy (correct answer us the one who practiced lifting). This question is coded as 'Answer 2' in the data.

Study 2. This study explored if children calibrate their own effortful behavior in response to the effortful behavior of others. In this experiment, there were two conditions, 'effort' and 'no effort'. In the 'effort condition', the experimenter played with a wooden box that was difficult to open (worked on it for 30 seconds before opening it) and in the 'no effort condition' the experimenter played with a wooden box that was easy to open (opened it after ~5 seconds). In both condition, the experimenter then gave the child a similar looking wooden box that was impossible to open to see how long they would spend working on it (the experimenter left to go talk to their parent about paper work and gave the child a bell to ring when they were all done playing). The children in the effort condition could either think 'wow, this toy took an adult a really long time to open, and adults are usually more able than me, so I should give up if this doesn't work' or 'it took the adult a long time to open this box, so I should probably spend some time trying to open it too because this is a challenging toy!'. Or they might think neither of these things and perform the same as the children in the 'no effort condition'. After the child rang the bell, or worked on it for four minutes (we ran this at the children's museum so I couldn't keep the child playing forever), the experimenter then told the child they messed up and gave them the wrong toy. Finally, the experimenter swapped the child's toy for the toy that could open, and had all children succeed in opening the toy in the end.

Questions/Hypotheses:

Study 1: Do children understand that domain specific effort leads to domain specific outcomes? Are children above chance on the two questions? Are more children than chance at 100% on this task (i.e. they answer both questions, which are really asking the same thing, correctly)?

Study 2: Do children in the effort condition play with the toy for longer than children in the no effort condition? Do I have enough data to even show this effect?

Variables:

Study 1:

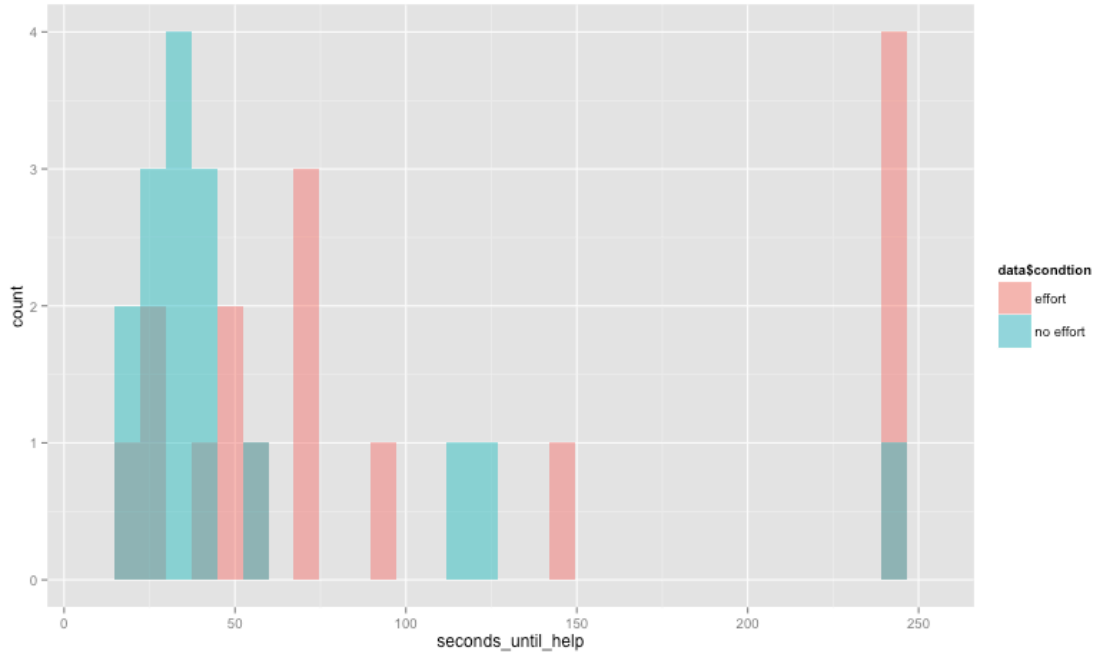
- Answer 1: response to answer 1 (1 or 0)
- Answer 2: response to answer 2 (1 or 0)
- Average – average response on answer 1 and 2 (0, 0.5, 1)

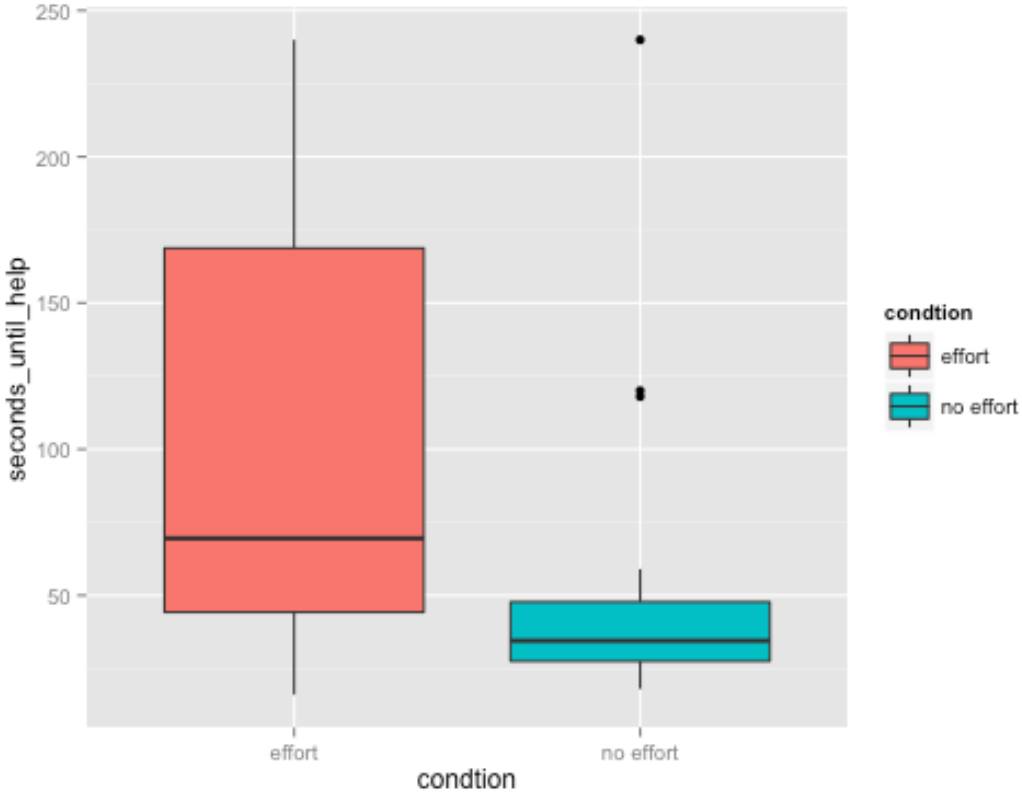
- Age (3 and 4)
- Sex (M and F)

Study 2:
- Age (4 and 5)
- Sex (M and f)
- Second until help: seconds until children rang the bell (ceiling is 4 minutes)
- Condition: effort or no effort

Interpretation of results:
Study 1: There were 18 kids in this data set and each was asked 2 questions. When asked which character the children thought would be able to execute the task to get their toy, children chose the character who practiced the task-specific action 72% of the time, ($p<0.01$; 95% CI: 57.45-100%; one-tailed **binomial test**). This analysis looked at, on average, which character the child chose (thus 36 trials over all). But, in order to tell if children were above chance for guessing both questions correctly, showing a true understanding of the task, we ran a different binomial test looking across 18 trials (chance now at 25%). In this analysis, the children were not above chance. Thus, it seems children did not totally understand this task.

Study 2: There were 16 kids/ condition in this data set (32 overall). The 'second until help' data were not normally distributed, thus we ran a permutation version of the t test and a Wilcox test to see if the condition effected total time playing with the toy. The **permutation t test** was not significant (p =0.078), while the **Wilcox test** was significant (p = 0.04). Because the data were not normally distributed and these two tests were inconclusive when taken together, we ran a **power analysis** to see if my sample size was too small to find an effect. Alas, we found we actually need 26 kids per group to find even a large effect! Therefore, we will collect more data!




250
200
150
100
50
seconds_until_help
effort
no effort
condtion
condtion
effort
no effort