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Impact on Creativity and Anxiety on Lynx Gene Polymorphisms

Haikun (Helen) Qiu

Eckardt Scholar Thesis

Faculty Sponsor: Dr. Julie Miwa

Fall 2020

## Introduction

Studying lynx proteins in mammalian species may lead to a greater understanding of the variable expression of anxiety and creativity in the human brain. Lynx genes are protoxin genes that bind with nicotinic acetylcholine receptors (nAChRs) in the cholinergic system. The cholinergic system is a modulator of the central nervous system. Several nAChRs are located within the amygdala and hippocampus, and the binding of these receptors influence the behavioral expression of fear and anxiety, as well as learning, memory, and creativity. Based on in vivo experiments on mice, a few hypotheses were generated that can be projected to humans. These hypotheses are the central theories for the Human SNP Study. The SNP study looks at the implications of single nucleotide polymorphisms (SNPs) in the lynx genes and their effect on fear/anxiety, learning, memory, and creativity. Regarding learning specifically, it is hypothesized that the lynx1 gene controls the critical period of plasticity. This period of plasticity is the brain's flexibility to acquire new information and generate new connections and only lasts in adolescence. Increasing the length of synaptic plasticity can potentially lead to higher levels of creativity. Regarding fear and anxiety, it is hypothesized that decreased expression of lynx2 leads to increased behavioral expression of anxiety.

To test creativity and anxiety in humans, a questionnaire containing multiple established psychological tests was given to students at Lehigh University. To measure the genomic portion of the study, their DNA was collected and analyzed. Prior to the psychological tests, a bio-demographic questionnaire (BDQ) created by a Lehigh University student specifically for the Human SNP study was issued. Then, the psychological tests administered were as follows: Creative Behavior Inquiry (CBI), Remote Associations Test (RAT), and State-Trait Anxiety Inventory (STAI).

Creative Behavior Inquiry (CBI) asks an individual to rate how many times they have received an achievement award in one of 90 creative categories, Remote Associations Test (RAT) presents an individual with three mutually distant associated words and then asks to find the word that relates all three cued words. State-Trait Anxiety Inventory (STAI) asks an individual to rate his/her state anxiety based on 20 questions with a numeric scale and trait anxiety based on 20 questions with a numeric scale.

### **Project Overview**

#### Hypotheses:

Single nucleotide polymorphisms found in the promoter region of lynx genes in the DNA sequences taken from participants will directly correlate to a change in creativity and anxiety levels. Higher anxiety and creativity scores have a strong correlation to the presence of SNPs.

#### Null Hypothesis:

There is no relationship between the presence of SNPs in the promoter region of the lynx genes and the anxiety and creativity scores collected.

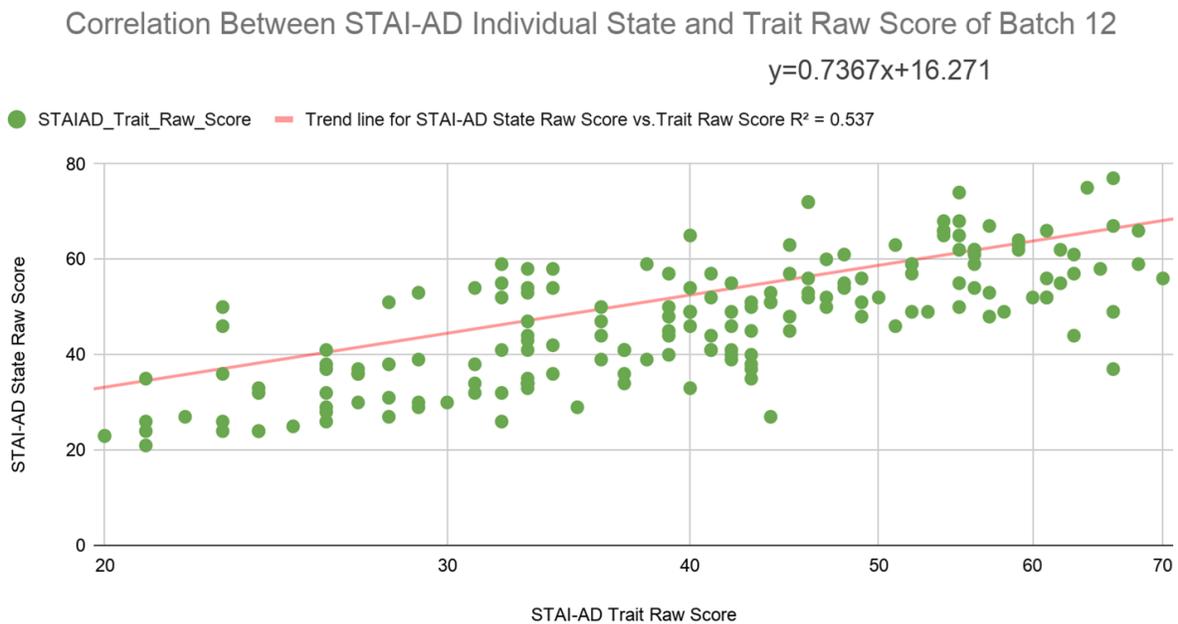
The test given to the participants consisted of BDQ, STAI, RAT, and CBI tests. Creativity and anxiety scores were determined by assigning numbers to the answers given by participants and combining them for an overall score. Three SNPs in the lynx1 gene and three SNPs in the lynx2 gene were compared to the psychology data. The overall scores for each batch were separated based on the presence or absence of the SNP being analyzed. The scores in each

grouping were averaged and the means were analyzed for significant variances. Significant variances imply that the SNP is correlated to the increase or decrease in the score.

## Data

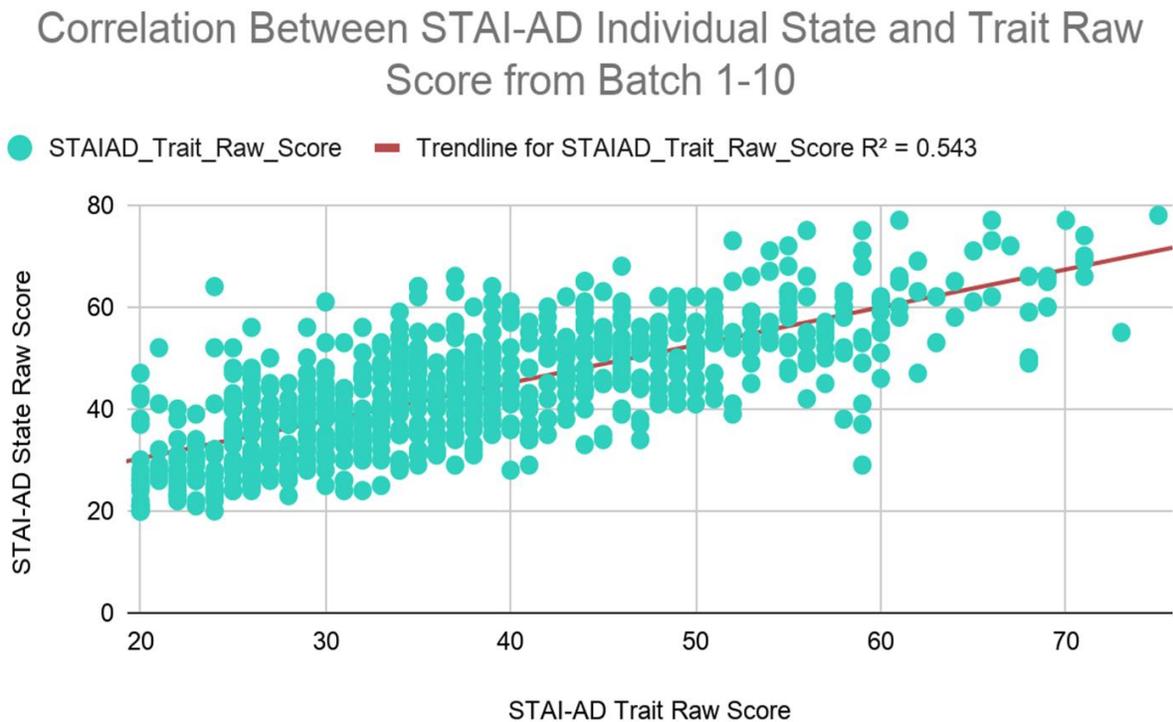
In Spring 2020, there were twelve human participants for the study. However, to respect the privacy of those individuals and in the interest of our timeline, the data that was scored belongs to participants from previous years.

Figure A :



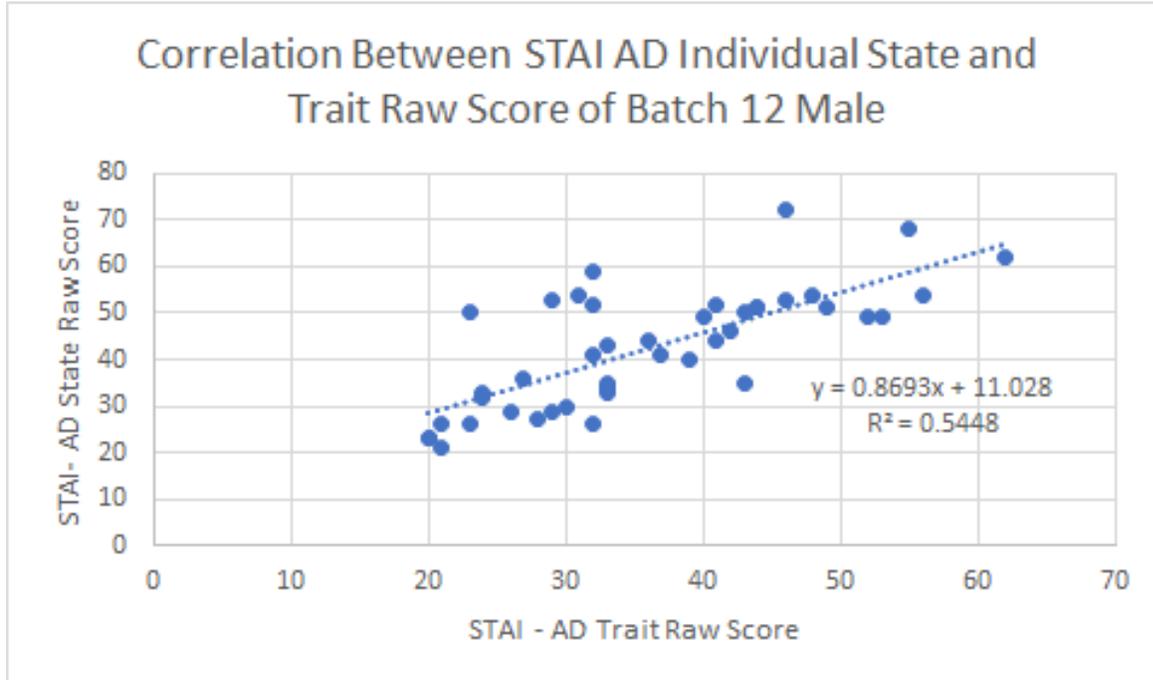
-A) Scatter plot comparing the state anxiety and trait anxiety scores from the State-Trait Anxiety for Adults (STAI-AD) in the 178 participants of Batch 12. The  $R^2$  value of 0.537 shows that there is a moderate correlation between the two scores.

Figure B:



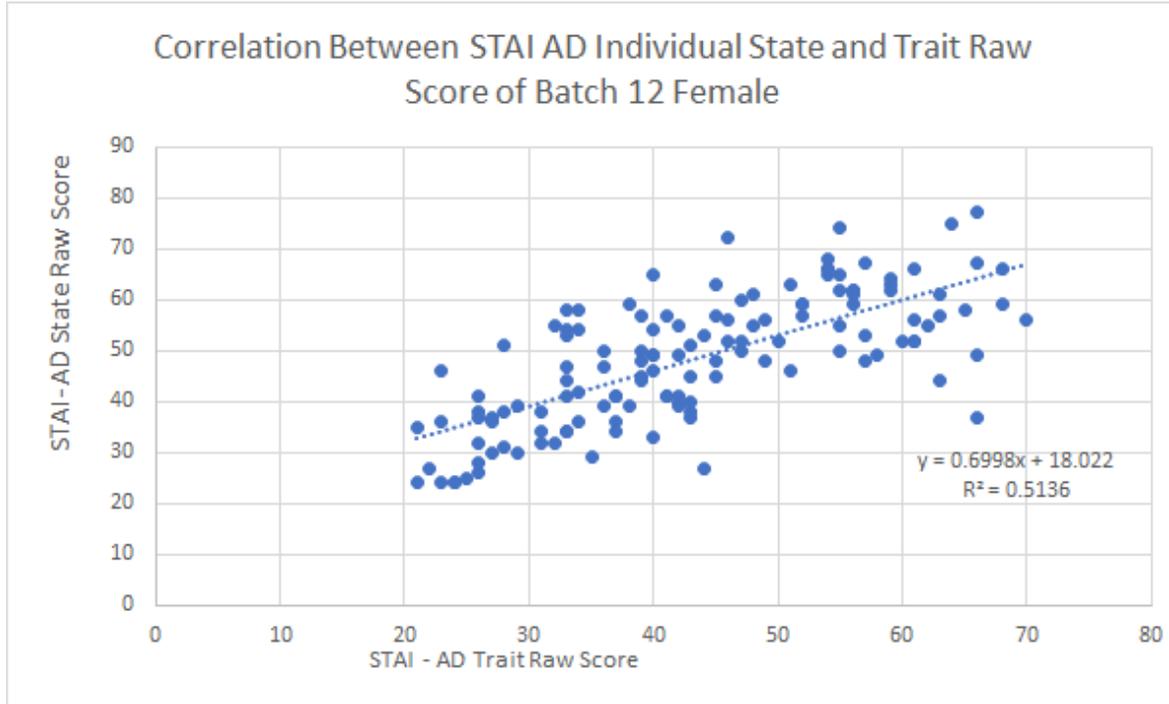
-B) Shows the relationship between the state anxiety and trait anxiety scores from the STAI-AD in 760 participants of Batch 1-10. Similarly, to the Batch 12 data, the  $R^2$  value of 0.543 also shows a moderate correlation between the two scores. The two graphs confirm the relationship displayed in figure A as it is consistent with the much larger participant pool represented by figure B.

Figure C:



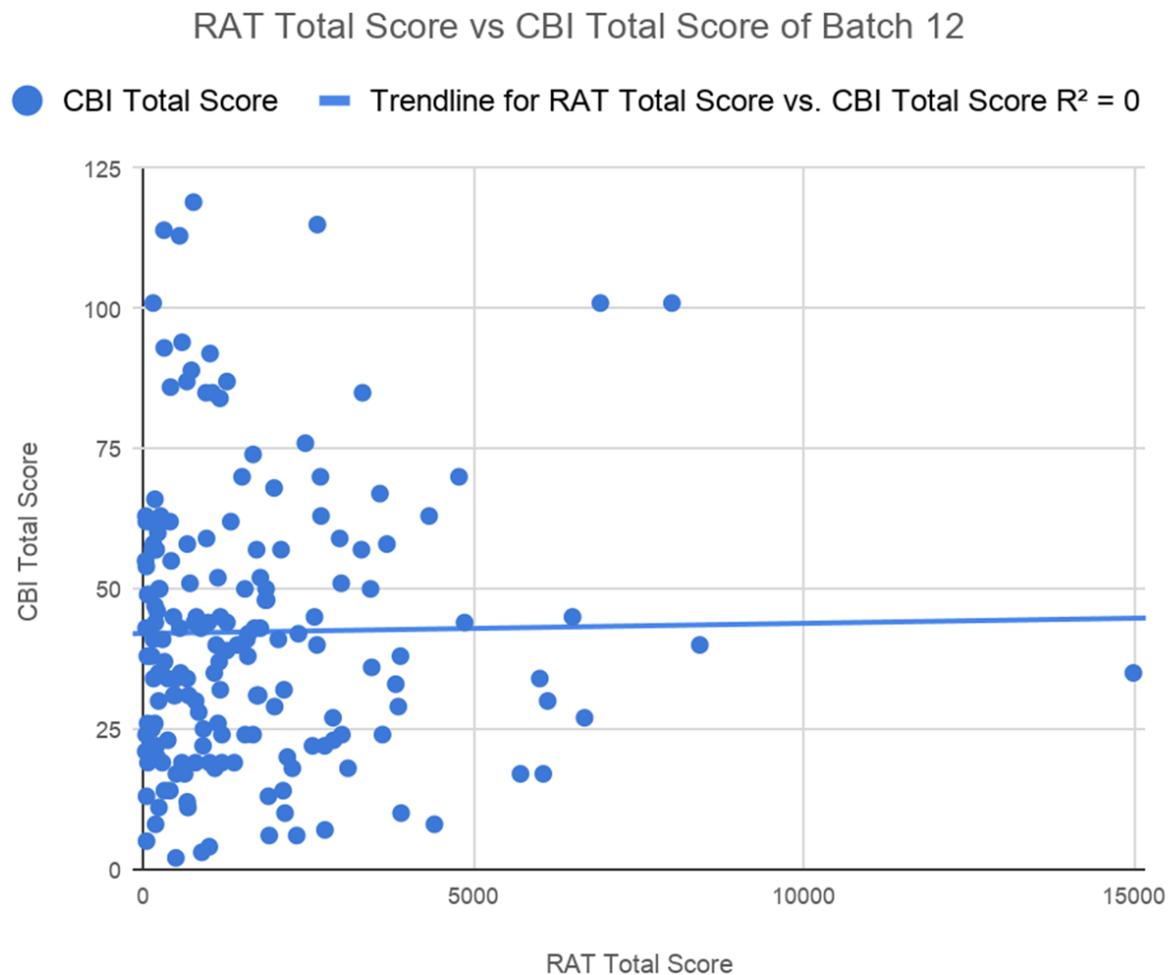
-C) A scatter plot shows the STAI state anxiety score in relation to trait anxiety score in Bach 12 male specifically. The plot has a R2 value of 0.545, indicating there is a moderate relationship between them. The Average State Anxiety Score is 36.045, with a standard deviation of 10.7. The Average Trait Score is 42.36, with a standard deviation of 12.62.

Figure D:



-D) Figure D shows the STAI state anxiety score in relation to trait anxiety score in Batch 12 female specifically. The plot has a  $R^2$  value of 0.514, indicating there is a moderate relationship between them. The Average State Anxiety Score is 43.40, with a standard deviation of 12.81. The Average Trait Score is 48.40, with a standard deviation of 12.50. Comparing Figure C, and D, there is a better correlation in male than female regarding how state anxiety relates to trait anxiety. Female statistics also show a bigger deviation than male, indicating female has more variabilities in this regard.

Figure E:



-E) The scatter plot compares scores from the two creativity tests, the Remote Association Test (RAT) and Creative Behavior Inquiry (CBI), in the 178 participants of Batch 12. The  $R^2$  value of 0 shows no correlation between these two creativity scores, however, this relationship may be skewed due to the scoring method of the RAT test. Because novel answers are given a new number, some scores can be very high without the higher numbers necessarily implying higher creativity. This can skew the data, as shown by the x-axis extending to 15,000 whereas the y-axis reaches 125.

## **Future Steps**

It is imperative that future research is done to extend our connections beyond biology students at Lehigh University. Continuing this study will increase the number and diversity of human participants analyzed, which would either confirm or contradict the information we have thus far about the link between SNPs on the lynx1 and lynx2 genes with a participant's creativity or anxiety levels. In order to further this study, we will continue efforts in running the study at DeSales University. Inviting a Principal Investigator from DeSales is the final step before submitting the completed IRB document for approval on their end.

We can continue searching for new groups willing to participate in research at Lehigh; the wider range we can get over multiple demographics, the stronger our data will be.

It is also important to adjust scoring methods for open response questions on the RAT test so that creating scores for novel responses is more straightforward and can lead to easier analysis post-scoring.

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