

Cogs 209 Mini-Project Proposal

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## **Assessing the bidirectional relationship between maternal depression/anxiety and infant anxiety/attachment patterns**

### **1. INTRODUCTION**

Disrupted maternal attachment provides challenges for the birthing parent and infant, and can result in long term duress for all parties involved. Infancy is a critical stage of development, where secure maternal attachment from the beginning of the baby's life promotes the best circumstances for psychological and physical growth. Impaired attachment runs the risk of altered neural development, psychological challenges, and permanent disruptions to the developing infant (Dekel et al. 2019, Handelzalts et al. 2021) and to the birthing parent's health long term. The distinct influence of different, but comorbid, maternal mental health difficulties, such as postpartum depression, anxiety, and/or childbirth-related posttraumatic stress disorder (CB-PTSD) on infant attachment and infant anxiety is not well understood, but are presently understood to impair emotional attunement and reciprocal attachment (Borji et al. 2018, Dekel et al. 2019, Erikson et al. 2019, Tolja et al. 2020). Birth related posttraumatic stress in particular may lead to intrusive traumatic birth reminders, hypervigilance, and avoidance symptoms that may lead to aversion to the infant, limited sensitivity, and disruption in the formation of a relationship between the birthing parent and the infant (Dekel et al. 2019, Erikson et al. 2019).

The purpose of the present study was to determine the bidirectional associations between baseline maternal anxiety/depression and future infant anxiety/attachment and duration of associations, as impaired attachment extends generationally. We hypothesized a bidirectional relationship whereby increased maternal anxiety and depression would lead to increased infant anxiety and attachment issues and vice versa. Given limitations in comprehensively assessing infant anxiety and attachment, and reliance on maternal self and infant report that may be subject to maternal bias, a combination of several standardized maternal-report questionnaires that simultaneously and comprehensively assess maternal mental health and infant attachment can be useful tools for understanding the relationship between the two.

## 2. METHODS

### 2.1. DATASET

The open source [dataset](#) contains answers from 410 participants of a battery of standardized maternal-report questionnaires. This dataset includes categorical (e.g. marital status), ordinal (e.g. responses to the questionnaires), as well as continuous (e.g. age, duration of infant night sleep, etc) variables.

### 2.2. PARTICIPANTS

Maternal eligibility criteria consisted of being the birth mother of an infant aged 3 to 12 months old, being  $\geq 18$  years old, and **speaking French**. For the 1.2% of participants who had twins, only data related to the first-born baby was used in the current study. 410 participants who had recently given birth were included.

### 2.3. INFANT MEASURES

*IBQ-R*. The Infant behavior questionnaire-revised is a parent-report measure of infant temperament that allows investigation of the relationship between different dimensions of temperament that are often obscured by the assessment of more global constructs. Items 3, 4, 9, 10, 16, 17, 28, 29, 32 and 33 of the Very Short Form of IBQ-R were assessed in the original dataset. We modified the IBQ-R, traditionally used to assess infant sleep and temperament, to be used as a measure of infant attachment and temperament by removing questions only associated with infant sleep. The possible responses to each question could vary ranging from “never” to “always” with 7 increments in total.

### 2.4. MATERNAL MEASURES

*City BiTS*. The City BiTS is a self-report tool measuring the frequency of CB-PTSD symptoms over the **last month**. The City BiTS contains 29 items, with 20 of them evaluating PTSD symptom clusters of the Diagnostic and Statistical Manual of Mental Disorders, 5th ed. (DSM-5; criteria B to E), namely intrusions, avoidance, negative cognitions and mood, and hyperarousal. The City BiTS contains the birth-related symptoms subscale and the general symptoms subscales. The birth-related symptoms subscale is composed of items assessing symptoms of intrusion, avoidance, and a few that measure negative cognitions and mood. The general symptoms subscale consists of the rest of the items assessing negative cognitions and mood, and

hyperarousal symptoms. Greater severity of CB-PTSD symptoms is suggested by a higher total score, which includes DSM-5 criteria B-E items (range: 0–60).

*EPDS.* This 10-item self-report questionnaire assessed maternal postpartum depression symptoms within the **last week**. A higher total score (range: 0–40) indicates higher symptom severity

*HADS.* Anxiety symptoms occurring in the last week were assessed with the HADS. The total score of this 7-item self-report questionnaire ranges from 0 to 21, with higher scores suggesting higher symptom severity

*BISQ.* This maternal-report questionnaire assessed various infant sleep variables over the previous week, such as nocturnal sleep duration (between 7 p.m. to 7 a.m.), number of night waking, and method of falling asleep with the following response options: while being fed = 1, while being rocked = 2, while being held = 3, alone in the crib = 4, and in the crib with parental presence = 5

*Sociodemographic and medical data.* The following information was collected via single items completed by the mothers: maternal age, marital status, and educational level (no education = 1, compulsory education = 2, post-compulsory education = 3, university of applied science or university diploma of technology degree = 4, and university = 5), as well as weeks of gestation, and infant gender and age ( $\geq 3$  months to  $< 6$  months = 1,  $\geq 6$  months to  $< 9$  months = 2, and  $\geq 9$  months to  $< 12$  months = 3).

Maternal measures were untreated except for the outcome, which was averaged and then treated as continuous variables.

## 2.5. STATISTICAL ANALYSIS

Clustering and linear regressions were performed with Python 3.10.11. Code for this project can be found [here](#). Descriptive and exploratory analyses were initially conducted to ensure data were cleaned and appropriate for analyses. To examine the associations between our exposures of interest and outcome, we used linear regression models using each of the parental surveys (individually) to test the association between exposure and outcomes. Next, we performed feature selection using Lasso and Random forest on all features combined to determine if any specific survey questions may be more predictive of infant attachment. In Lasso models, we tested a wide array of alphas to examine the influence of higher penalty on the features. In

Random forest, we calculated the feature importance of all features. Finally, we tested the polynomial degree fit of our model based on the features selected using Random forest.

### 3. RESULTS

#### 3.1. Sample Characteristics

Most participants (95%) are dual household parents. The average participant was 30 years old, and most participants (99%) attended compulsory school. The average gestational age is 39 weeks, and 51% of babies were assigned female at birth.

#### 3.2. Infant attachment

We performed correlations across IBQ-R features (Figure 1) to streamline the questions that would be used for further analyses. We found that most measures were positively correlated with each other. For future analysis, we chose the measures named below 4, 16, 28, 32, and 33.

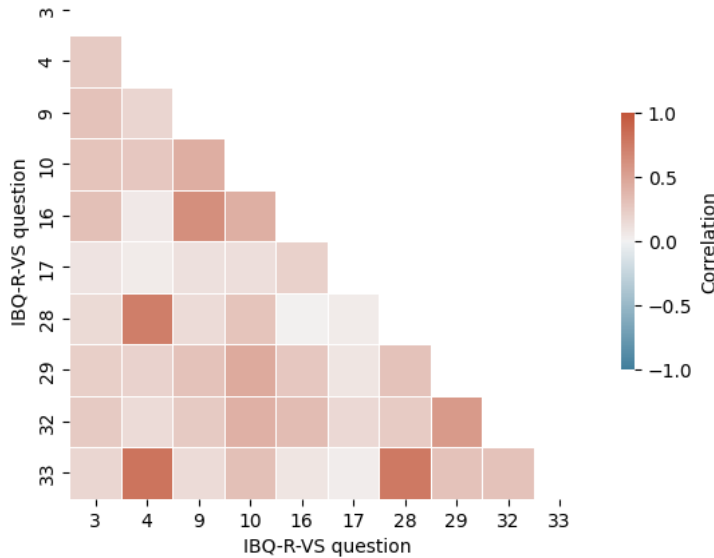


Figure 1: Correlation across IBQ-R survey questionnaires

#### 3.3 Distribution of attachment severity among subjects:

In order to assess the spread of infant attachment across participants, we used the new 5-item questionnaire derived from the above correlation matrix. As the responses yielded from normal temperament would lie in the middle of this range, we shifted the answers to span  $[-3, 3]$  and then used the square value of the response so that either end represents “poor” attachment (Figure 2). The final metric of the severity of infant attachment is measured as the sum of all 5

aforementioned questions (hereafter referred to as infant attachment severity index) . IBQ-R responses were treated as continuous variables.

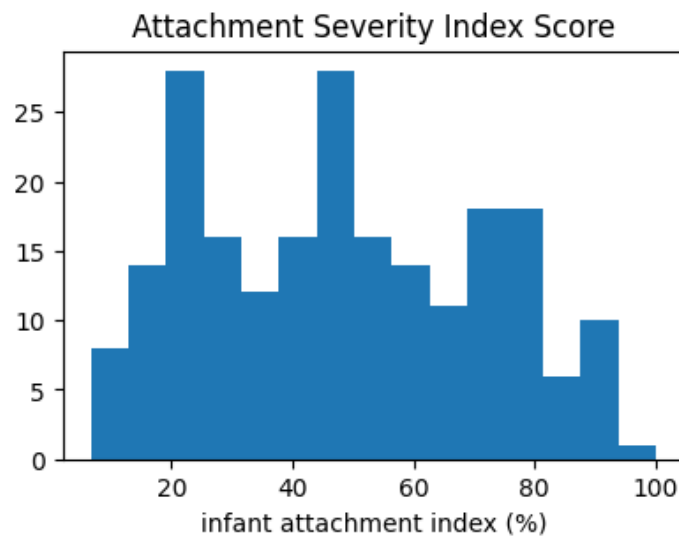


Figure 2: Measurement of attachment index across participants

### 3.4 Model comparison and Visualization

We compared the efficiency of Lasso regression and Random forest classifier for feature selection in our data.

### 3.5 Lasso regression

First, we compared the strength of the association between each of the maternal measures and the infant attachment severity index, under different penalties on the features ( $\alpha = 0.0001, 0.05$  and  $1.5$ ). HADS 11, EPDS 4, CBTS 12, 13, 14, 20 and 21 were found to be most predictive of the infant attachment severity index (Figure 3). Next, we ran several lasso models to test for the best alpha value. The alpha value that led to the lowest error in test data also resulted in a large increase of training error (Figure 4). In short, we found that increasing the regularization parameter, which removed many coefficients from the model (reduced beta to 0), led to a better fit compared to a traditional linear model.

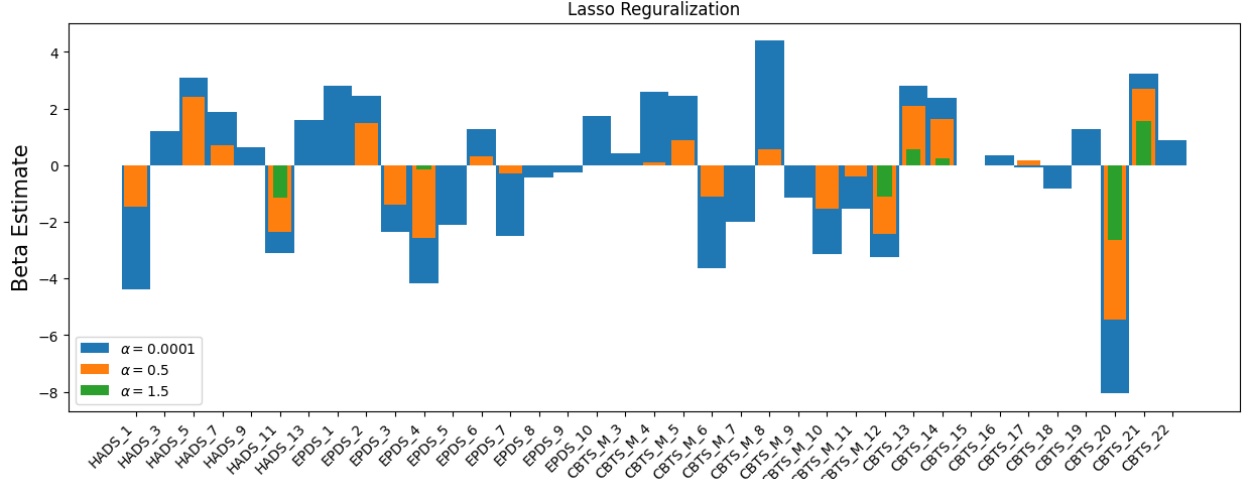


Figure 3: Lasso regression with maternal measures as predictors and infant attachment severity index as the target for 3 alpha values: 0.0001, 0.5 and 1.5.

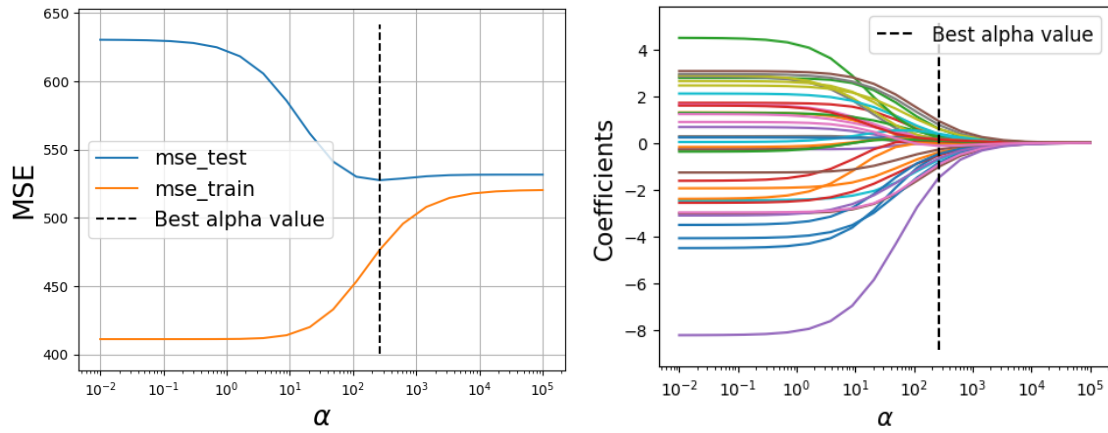


Figure 4: K-fold cross validation for our Lasso regression model. Left shows train and test data for each alpha value, and right shows coefficient values for each alpha. Best alpha value = 263.6

### 3.6 Random forest feature selection

We used Random forest feature selection as another model (in comparison to Lasso regression) for assessing which maternal measures had the highest feature importance for predicting infant attachment severity index. HADS 11 and CBTS 20 and 21 were found to be the most important features (Figure 5).

Finally, in order to assess the **best polynomial degree of the model** for our data, we selected the top 10 features based on the Random Forest Model. Then, we ran polynomial models (from 1 to 4 degrees) and assessed the training and test error for each of these models. We found that the one degree fit was the best fit for our model, and any increase in non-linearity did not help in

the testing performance even though training performance went down.

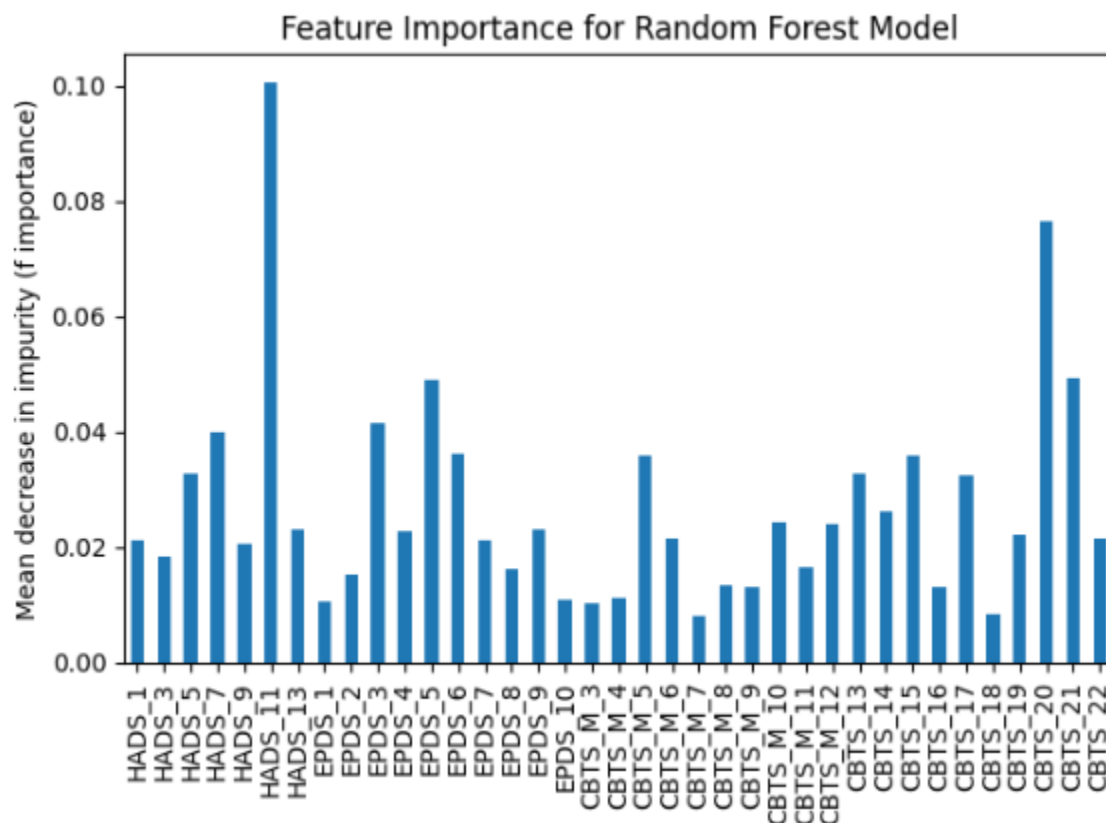


Figure 5: Mean decrease of **impurity** for each measure using Random Forest.

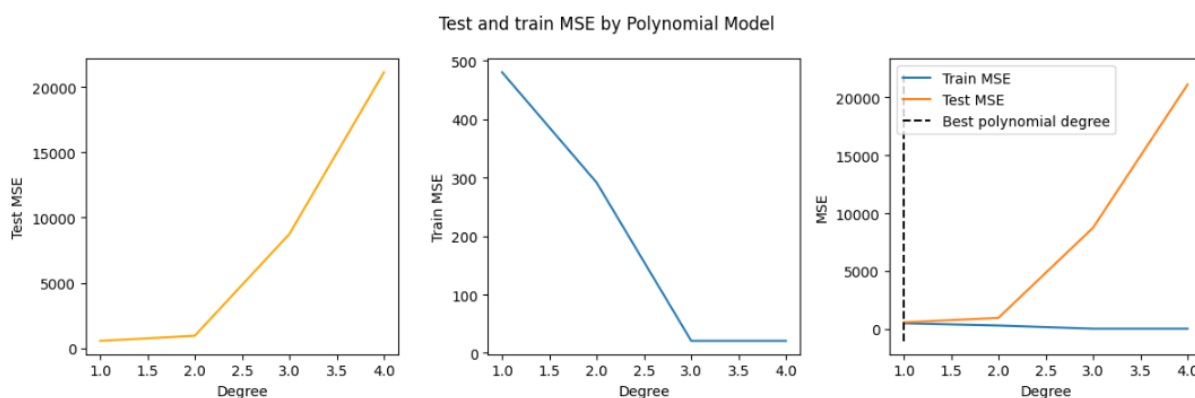


Figure 6: Train and test MSE by polynomial degree fit for top 10 selected features using Random Forest.

#### 4. DISCUSSION

In this study, we used linear and non linear models to examine the association between several questionnaires and infant attachment index. We compared Lasso regression Random forest

models for selecting maternal measures that were most predictive of infant attachment. Both models suggest that CBTS 22, CBTS 21, and HADS 11 had the strongest association with infant attachment severity index. Nevertheless we used the top ten features from Random Forest Selection to assess the polynomial degree fit of our model because the best alpha value based on K-fold cross validation for our Lasso regression model removed most of the coefficients from the model.

This could have several potential implications - (i) additional maternal measures are required to predict infant attachment severity index, as defined by our initial correlation matrix; (ii) the infant/ maternal measures included in the current dataset do not fully assess all important aspects of infant attachment/ maternal mental health respectively; (iii) our definition of the infant attachment severity index is somewhat lacking; or (iv) more sophisticated and in-depth analysis/ data curation is required to uncover the bidirectional relationship between maternal mental health and infant attachment.

The top selected measures in Random Forest Model, which include “Feeling troubled or started easily” (CBTS 20), “Having trouble concentrating” (CBTS 21), and “I'm fidgety and can't keep still” (HADS 11), all seem to be associated with parental anxiety. These results suggest that parental anxiety may be the best indicator for infant anxiety. Indeed, a meta analysis found that there is a strong genetic component in anxiety. While the reason for child attachment could be due to inherited anxiety, children could instead be learning it from their parents.

These analyses uncover important dynamics between maternal mental health and infant attachment and anxiety. We believe these results also give insight into additional factors that may be important for assessing and intervening with such relationships. Future analysis should include genetic information to further understand the possible behavioral and genetic components in these relationships.

## **5. SUPPLEMENTAL**

Questionnaires

City BiTS



3. Repeated, involuntary memories of the birth (or parts of the birth) that you cannot control
4. Bad dreams or nightmares from birth, or related to birth
5. Flashbacks of birth and/or reliving of experience
6. Being confused when something reminds you of the birth
7. Being tense or anxious when something reminds you of the birth
8. Trying to avoid thinking about the birth
9. Trying to avoid things that remind you of the birth (e.g. people, places, TV shows, etc.)
10. Unable to remember birth details
11. Blaming yourself or others for what happened during the birth
12. Having intense negative emotions about the birth (eg, fear, anger, shame)
13. Having negative beliefs about yourself, or fearing that something terrible is happening
14. Losing interest in activities that were important to you before
15. Feel detached from others
16. Unable to feel positive emotions (eg, joy, excitement)
17. Feeling irritable or aggressive
18. Feeling self-destructive, or acting recklessly
19. Feeling tense and on edge
20. Feeling agitated or startled easily
21. Having trouble concentrating
22. Poor sleep due to things unrelated to the baby's sleep pattern

### EPDS

1. I was able to laugh and take things on the bright side:
2. I felt confident and joyful thinking about the future:
3. I blamed myself, without reason, for being responsible when things went wrong:
4. I felt worried or worried for no reason:
5. I felt scared or panicked for no real reason:
6. I tended to feel overwhelmed by events:
7. I felt so miserable that I had trouble sleeping:
8. I felt sad or unhappy:
9. I felt so unhappy that I cried:
10. I have thought about hurting myself:

### HADS

1. I feel tense or upset:
3. I have a feeling of fear as if something horrible is going to happen to me:
5. I'm worried :
7. I can sit quietly and do nothing and feel relaxed:
9. I experience feelings of fear and my stomach is in knots:
11. I'm fidgety and can't keep still:
13. I experience sudden feelings of panic:

### IBQ-R questions (3, 4, 9, 10, 16, 17, 28, 29, 32 and 33)

3. When tired, how often did your baby show distress?
4. When you introduced him/her to an adult he/she didn't know, how often did your baby latch on to a parent?
9. When it was bed or nap time and your baby didn't want to go, how often did he/she whine or sob?
10. After sleep, how often did your baby cry if no one came quickly?
16. How often did your baby seem angry (crying and fussing) when you put him to bed?
17. How often in the past week has your baby been startled by a sudden change in body position (for example, being moved suddenly)?
28. When you introduced him/her to an adult he/she did not know, how often did your baby refuse to go to this unknown person?
29. When you are busy with another activity, and your baby can't get your attention, how often does he/she cry?
32. When your baby wanted something, how often did he/she get upset when he/she couldn't get what he/she wanted?

33. When he/she was in the presence of several unfamiliar adults, how often did your baby cling to a parent?

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