**Title: Investigating the effect of mood on risky decision making behavior**

**Introduction**: Day to day decisions like whether to take a bus or a cab, or whether to attend a lecture are many times affected by whether we are having a ‘good’ day or a ‘bad’ day. Many studies in the past have shown that the emotional state of the brain influences ‘decision making’. Investigating how the ‘mood’ asserts its effect on decision making would facilitate better understanding of this process and forms the broader aim of my proposal. Insular cortex is thought to process interoceptive information and to form the neural substrate for emotion4. Harle et al1 showed that participants who were induced into a sad mood by means of showing them a video clip, performed significantly different on the Ultimatum Game (UG) task, than the participants in the neutral mood. Sad mood participants showed higher activation of right Anterior Insular cortex (AIC) at the time of presentation of an unfair offer, as compared to neutral mood participants. Moreover, the activation of Right AIC was a strong determinant of the acceptance rate of the offers (Negatively correlated). In another study, Thielscher et al2 observed that, in a fear-disgust discrimination task, the activation of right or left AIC was strong predictor of whether the decision was in favor of ‘fearful’ or ‘disgusted’, respectively. The reaction times for identifying a fearful vs a disgusted face were significantly different. Various studies, including the ones mentioned before show that the ‘mood’ or the ‘emotion’ could be affecting the decision making process, through Insula. I am interested in quantitatively understanding how the activation level in insula influences the performance on risky decision making task.

My objective is to obtain a concrete relation between activation in insula, the risk aversion in risky decision-making task and the subject-reported mood. As a result of this study, I expect to

1. Establish a quantitative relation between Insula activation and risk aversion. Risk aversion = f (Insula activation)
2. Test the hypothesis that Insula activation is a good indicator for the subjective feeling of ‘mood’

**Experimental design**:

**Subjects**: I would be recruiting nicotine addicted subjects. **Why so?** Studies have shown that deprivation of nicotine in addicts, leads to stronger connection between Insula and Amygdala, further causing higher activation of Insula, as compared to addicts who have had their daily dose of nicotine4. This motivated the idea to recruit these subjects and let them gamble for nicotine, which means that they would be rewarded with nicotine at the end of every trial. It is expected that, as the trials proceed, the participant would get satiated, causing a decrease in activity levels of the insula. This would allow me to obtain a continuous variation in insula activation, in a single subject. This would avoid inter-subject variability and allows to look at effect on Insula activation on decision making within one subject. Subjects would be recruited through Craiglist.

**Task**: Two alternative forced choice task. I am using the same paradigm as described in Fukunaga et al3. Each subject would perform 180 trials. In one trial, a subject would be presented with two options. Option 1: A gamble, presented as a pie chart showing the probability of winning three different rewards. “Reward’ here is the amount of time for which the valve of an e-cigarette would open and the subject would inhale the Nicotine vapors. There would be five different gambles with mutually orthogonal values of probability of loss, maximum possible loss and variance of possible outcomes, accounting for different risks. Option 2: A fixed deterministic reward (let us call it ‘Sure Thing’ or ST).

The fMRI activity of the subjects as they go through the trials would be monitored. After each trial, they would also be asked to rate their mood on a scale of -2 to 2, relative to their mood when they came in for the experiment.

**Data Analysis**: (A) The fMRI data would be analyzed using GLM in SPM5. The regressors would include various characteristics of the gamble and the subjective rating of the mood by the participants. This would identify the areas in brain that show activity in response to various types of risks. Previous study by Fukunaga et al showed that Anterior Cingulate Cortex (ACC) activity is sensitive to the risk representation of ‘variance in outcome’3. Here, the objective is to identify the neural substrates of other risk types. Further analysis would involve finding the correlation between Insula activity, subjective ratings of the mood and the activity in areas associated with representation of different risk types.

(B) To understand how decisions were affected by mood, a binary logistic regression of the choice probability of gamble would be carried out with subjective rating of mood and value of the sure thing as predictors. Further, parallel analysis with Insula activity as a predictor would reveal whether Insula could be a more reliable predictor of behavior in risky decision making.

It is expected that Insula activity would show a negative correlation with mood ratings1. Further, the mood ratings would improve, and insula activity would decrease as the subjects proceed through the trials and get more and more satiated4. Not much is known about how mood affects the risky decision-making behavior in addiction and hence, no specific claims for how risk aversion would change as function of mood or Insula activity can be made.

**Future Studies**: I would like to apply the results of this study to further understand whether specific external activation of Insula could induce a particular mood, to see whether the causal relationship between mood and Insula is one way or both ways. Further, it would be interesting to see if external activation of Insula could lead to change risky decision making.

**Intellectual merit**: The current practice of incorporating mood as an independent variable involves asking the participants to rate their mood at the beginning of the task. However, monitoring and manipulation of the neural substrate for ‘mood’ would provide for a more accurate handle to study its effect on decision making. One outcome of the proposed study is the quantitative relationship between mood and Insula, which is a putative substrate for mood.

**Broader Impact**: The proposed study encourages the participation and inclusion of people with addiction who often suffer social exclusion due to their substance abuse habits. Moreover, the outcomes of the study hold application in understanding remission from addiction. Studies have shown that high activity in Insula is a good predictor of relapse while damaged Insula resulted in complete remission 4,5.

Work cited: 1Harle et al. (2012). NeuroImage. 2Thielscher et al. (2007). J Neurosci. 3Fukunaga et al. (2018). Front Neurosci. 4Droutman et al. (2015) Trends Cog Sci. 5Naqvi et al (2007). Science