1. Project name: The impact of anticipated anxiety on reward and aversive learning

2. Lead researcher: Chih-Chung Ting

3. Data steward: Chih-Chung Ting

4. Research question(s):

(1) How do individuals evaluate feedback (e.g. factual and counterfactual feedback) in reinforcement learning under safe and anxious conditions?

(2) How does anxiety bias sensitivity to positive and negative values and impact learning performance?

(3) How do conditions of anxiety impact reinforcement learning about rewards and punishments in relevant neural circuitry?

5. Data to be gathered (including location): The behavioral and physiological data (i.e., skin conductance response: SCR) were gathered using computer and laptop in the room E7.20 in the E2, Roeterseiland Campus

6. Method of data collection (in case of personal data indicate the basis (*grondslag*)):
General procedure:
Participants are required to sign the inform consent and fill out questionnaires when they arrive. The questionnaire comprises three part: (1) Biographic information (2) State-Trait Anxiety Inventory (STAI) (3) Beck Depression Inventory (BDI). After the questionnaires, we will introduce the reinforcement learning task to participants and make sure they fully understand. During the main task, eye movement and skin conductance responses are simultaneously recorded during the probabilistic reinforcement learning task (See Probabilistic Reinforcement Learning Task we described below). The task is preceded by an individual stimulation thresholding procedure (See Emotion induction technique we described below). The whole experiment takes around 1.5 to 2 hours, which includes preparation, main task and post experimental debriefing.

Experimental design:
- Emotion induction technique
Each participant have to complete learning task under both threatening context (with anticipated anxiety) and safe context (without anticipated anxiety). To induce anticipated anxiety, we will administer electrical stimulation with DS5 Isolated Bipolar Constant Current Stimulators (Digitizer Ltd.) and ring electrode. The electrode will be positioned above the first or fourth dorsal interossei muscle of the left dorsal hand to provide the stimulated shock. The intensities of stimulation should be individually calibrated before the task. To this end, participants will experience electrical pulses of different intensities repeatedly with randomized order. After each pulse, participants have to rate their feeling on visual analog scale, from 0 (Not painful at all/ hardly perceptible) to 10 (unbearable painful) in steps of 1 point. Only stimulation intensities with rating of 8 will be used as experimental treatment.
To control the sensitization or desensitization, participants have to rerate the stimulation intensities after each run. According to the latest rating, we also modify the stimulation intensities for next run.

During each run, threatening context (with anticipated anxiety) and safe context (without anticipated anxiety) are presented in a blocked fashion. In the threatening context/block, stimulation will occur at unpredictable time points during reinforcement learning period. Specifically, the number of stimulation events is determined by random draw from gamma distribution (shape parameter, 1; scale parameter, 1), the timing of these stimulation event is determined by random draw from uniform distribution. In addition, the successful shocks are separated by at least 0.2s. On the other hand, there is no stimulated shock in the safe context/block.

- Probabilistic Reinforcement Learning Task
The experiment consists of around 5 runs. Each run comprises threat blocks with electric shocks and safe blocks without electric shocks. These blocks are pseudorandomly interleaved so that not more than two blocks of the same context will follow each other. At beginning of each block, participants are informed the type of blocks by a cue.

Our experiment is a 2 (Threatening/safe) by 2 (Reward/ Loss) by 2 (partial feedback/ complete feedback) factorial design. There are 16 symbols and constant 8 pairs associated with specific condition throughout the experiment. On each trial, the two symbols display simultaneously are not equivalent. One is on average more advantageous than the other. In the other words, in the reward learning condition, one of symbols often brings gains (+0.5 EU, 75%) and another one brings no gain (+0.0 EU, 25%); in the aversive learning condition, one brings less losses (-0.0 EU, 25%), but another is worse (-0.5 EU, 75%).

The goal of the game is to win as much money as possible by purchasing the reward or avoiding the loss. Therefore, participant have to make a decision about which one of two symbols they prefer by pressing button. Once participant choose a symbol, the outcome will be drawn from the corresponding probability of reward/loss and displayed on the screen: win money (+0.5 EU), not earn anything (+0.0 EU), or lose money (-0.5 EU).

At the end of each run, the total participant fee is equal to 10 EUs, pluses the sum of the earnings of all runs.

7. Individuals involved in data gathering, data manipulation/editing and with access to the data: Chih-Chung Ting; Isabela Lara Uquillas; Jan Engelmann; Mael Lebreton

8. Data Protection Impact Assessment: N/A

9. Data editing/manipulation steps (e.g. SPSS Syntax files, R scripts). Data is analyzed using Matlab

10. Where and how will the data be stored (including temporary storage for research use) and security measures applied: Data is anonymized and is stored on figshare.

11. Approval EBEC (Economics & Business Ethics Committee) obtained: approval yes/no

12. Intellectual property, copyright and ownership of the data: Chih-Chung Ting; Jan Engelmann; Mael Lebreton