**HUMAN HABIT LEARNING – Replication of the behavioral study in Tricomi et al., (2009). Detailed Protocol**

**Overall view of the design**

We will have two experimental factors with two conditions each:

1) A between participants factor consisting of the amount of training: 3-days vs 1-day. Participants of the 3-days group will come to the laboratory on three days in a row for 3 experimental sessions. Participants of the 1-day group will come at the laboratory only one time for one experimental session.

2) A within participants factor consisting of the treatment to the associated food outcome: valued vs. devalued.

**Participant recruitment**

*Inclusion criteria:* (1) like to snack (2) willing not to eat for 6h prior of each experimental session.

*Exclusion criteria:* (1) currently dieting (2) food allergies

**Standardized aspects**

*Experimental room:* The testing room should be kept identical for each day of testing of each participant. Specifically, the same room should be used for each day of testing, and efforts should be made to keep the room environment as similar as possible across days for a given participant (i.e. the testing desk/computer should be kept in the same position and all other objects/environmental cues kept the same). Finally, the room should be kept relatively dark. The purpose of this is to keep contextual cues as similar as possible across training and testing episodes, and the darkness may help to minimize attentional distraction and also is more similar to the darkness of the scanning environment in which the original experiment was run.

*Experimenter*: To further control for contextual cues,the experimenter collecting the data should be the same for all participants, this is particularly important when multiple sessions are collected.

*Testing time:* Participants of the 3-day training group should ideally be run at a similar time of the day for each experimental session – once again controlling for contextual and potentially hormonal variation effects on habitization. In practice, participants’ scheduling constraints may mitigate against achieving perfect alignment of scheduling across days – but it would be advisable at minimum to keep each participant consistently to either a morning or afternoon slot. Furthermore, we should record the time of test, so as to use this as a possible between subjects’ covariate to test for a moderating effect of time of day.

*Instructions:* The complete instructions will be given only at the beginning of the first session. During the second and the third session participants of the 3-days group, it will just be pointed out that participants will be doing the same task they did during the first session.

*Questions:* Inevitably, some participants may ask whether they will still receive the snacks, or whether they still have to press the buttons before starting the session after devaluation. The experimenter should simply answer that same rules of the previous sessions apply the current session, without giving any further details.

**Procedure**

*Questionnaires:* Participants will be asked to complete the EAT-26 questionnaire and a demographic questionnaire that will contain also questions on their height and weight and food allergies, which will serve as a screen to exclude individuals with eating disorders.

*General instructions:* The experimenter will explain the general structure of the experiment (e.g., how many sessions, what each session will consist on, how the food stimuli will be used, when they will get paid).

*Snack selection:* Participants will be presented with a selection of individual pieces of 6 snacks divided into two categories: sweet and savory. Each one of the four laboratories will select these snacks among the most popular options in their respective countries, aiming to match approximately for the size of the individual pieces and amount of calories per unit across labs/countries. Participants will be asked to taste each sample and choose their favorite savory snack and their favorite sweet snack. The favorite sweet and savory snack chosen by the participant will be used as food outcomes for the other phases of the experiment.

*Initial hunger and food pleasantness ratings:* Participant will use Likert-scales to evaluate their level of hunger (1, very full 10, very hungry) and the pleasantness of their favorite savory and sweet snack. The experimenter should underline that we are not interested on how much they like the snack in general, but rather how much they liked that particular piece they just ate “right here” “right now”.

*Interactive instructions and practice:* During the first session, participants will go through some interactive instructions on the free operant task and through a short practice. During this phase they should be encouraged to ask questions to the experimenter. The interactive instructions and the practice are administered on the first session only and will not be repeated on the second and third session.

*Free operant training:* Participants will see fractal images and asked to press on keyboards to gain snack items (as explained during the active instruction phase). Key-pressing responses to fractal cues will be rewarded on a random interval schedule with two possible food outcomes (a sweet and a savory snack) to be consumed following the task. One group of participants will perform two 8-min training sessions on 1 day (1-day group), whereas a second group of participants will perform four training sessions each day for 3 days (3-day group). Each session will be divided into 12 task blocks (20–40 s each) and eight rest blocks (20 s each). During the task blocks, a fractal image will be shown on the screen, along with a schematic indicating which button to press. Thus the start and end of the fractal image display will indicate the start and end of the block. Participants will be instructed to press the indicated button as often as they like; after each button press two possible outcomes could appear on the screen: either a gray circle, indicating no reward, or a picture of a sweet snack or savory snack, indicating a food reward corresponding to the picture. Only presses of the indicated button will lead to the display of the gray circle or food picture: if a different button is pressed, the display will not change. Rewards will be delivered on a variable-interval 10-s reinforcement schedule. Different fractals and response keys will be paired with the two outcomes, and these stimulus–response–outcome associations will remain consistent throughout the experiment (although they will be counterbalanced across participants). A third fractal will indicate a rest block, during which participants will be instructed not to respond. The block order will be pseudorandomized, with no block type occurring twice in a row. Following the final session of training, one of the two food outcomes will be devalued.

*Performance feedback and reward delivery:* At the end of each one of training sessions participants will receive a feedback on their total snack earnings and they will be given the amount of each snack they won divided by two to eat before continuing with the experiment. The snacks will be provided in two large bowls. The experimenter will be wearing gloves when handling the snacks.

*Stimulus contingency test:* Only during the first session, participants will perform a stimulus-outcome contingency test. They will see a fractal appearing on the screen and they will be asked to evaluated on a Likert scale how likely the button press was to result on the delivery of a savory or sweet snack (-5 sweet snack very likely 5 savory snack very likely) when that particular image was displayed.

*Devaluation procedure:* After the last training session participants will see a screen that says “Bonus! All you can eat M&M” (the name of the snack will depend the initial snack selection and the target for the devaluation). Participants will be brought to a different room for the devaluation procedure. The devaluation procedure should be done in a different context to the test situation to be more similar to the original experiment that tested in the scanner and implemented the devaluation outside the scanner. This is important because doing the devaluation in the same testing context could remind participants of the action-outcomes relationships. Participants will be asked to eat one of the foods until it is no longer pleasant to them. The food chosen for the devaluation procedure will be counterbalanced across participants. The snack will be provided in a large amount in a large bowl. The experimenter will tell the participants that usually people eat more than a single bowl and that the size of the bowl is arbitrary. The experimenter should stay in the same room as the participant during the devaluation procedure. When the participants decide to stop eating, the experimenter will ask if they are sure and reiterate that most people need several bowls before they find the snack unpleasant. Once they are done eating, they will be asked evaluate on Likert-scales their hunger (1, very full, 10 very hungry) and how pleasant they would find another piece of the savory and sweet snack (-5, very unpleasant; 5, very pleasant). If the experimenters have not implemented devaluation studies in human participants before, they should attempt the whole experimental procedure as a practice run in a few 1-day pilot participants, before beginning the official experiment, to make sure they feel comfortable with the devaluation procedure and are implementing this procedure effectively.

*Rating of the fractal images:* At the very end of the experimental procedure participants will be asked to evaluate on a Likert-scale the pleasantness of the fractal images (-5, very unpleasant; 5, very pleasant).

*Extinction test:* To test the effects of the devaluation procedure on behavior, a 3-min extinction session will be administered. The extinction test will be implemented in the same manner as for the free operant training sessions; however, no rewards will actually be delivered during extinction. Our key dependent variable will be calculated as follows: for each condition and each participant, we will calculate the responses per second in the last training block and in each of the three extinction blocks and then subtract the training press rate from the average press over the extinction blocks

*Payment and debriefing:* Finally, participants will fulfill a debriefing questionnaire, they will be paid for their time and effort and they will be given the opportunity to ask more questions on the experimental procedures.

*Weighing the food:* The snacks contained in the large bowl will be weighed at the beginning and at the end of the devaluation procedure in order to quantify the amount of food consumed by the participant during the devaluation procedure. To be sure that this procedure occurs outside the sight of the participants, the measurements will be done before the participant arrives and after they leave.