ROSES study description of aversive version of Luigi’s task

**Noise calibration:**

Use the subject’s ratings to find 2 different noises with the same level of unpleasantness. Present 10-15 candidate sounds (e.g., white noise, mechanical screech, buzzing alarm). Have participants rate each one on unpleasantness (1–5) and arousal. Select two noises matched on average rating, both >3 in aversiveness. The two selected noises should be easily distinguishable and different in qualitative features (e.g., a buzz vs. a siren) but not in subjective intensity. Also, choose a 3rd different noise for timeout trials with equal or higher unpleasantness.

**Volume calibration:**

Keep noise level consistent with a sound level meter or consistent headphone output. We could also do volume calibration like we do for the weather task.

**1st Phase: Instrumental phase**

In the Instrumental learning phase, participants learned the association between two responses (R1 or R2) and two corresponding rewarding outcomes (O1 and O2). On each trial picture of a control panel was presented in the center of the display (ITI, 500-1500 ms). Then, two levers appeared on the bottom left and right of the control panel, until the participant’s response. The responses consisted of choosing one of the two levers presented on the display, that could be selected through two buttons on a button box. To ensure engagement with the task, the participants are informed that if they do not press any levers, they will receive a 3rd different aversive noise). For each response (R1 and R2, left or right buttons counterbalanced between participants), the aversive outcomes would be the same O1 (visual 1 + noise 1) and O2 (visual 2 + noise 2) that would be used in the Pavlovian learning phase. An imbalance in the probability of obtaining the two aversive outcomes is introduced: choosing R1 (rich option) prevents the aversive outcome O1 with a 70% probability, whereas choosing R2 (poor option) prevents the aversive outcome O2 with a 30% probability. If participants chose within 2000 ms, the selected lever is lowered. Based on the probabilities of R1 and R2 leading to O1 and O2, participants might receive either an aversive picture paired with a loud noise or a message reading “alarm turned off,” indicating successful avoidance of the alarm. This outcome is displayed below the control panel next to the levers for 1000 ms. Additionally, a “baiting rule” is added, such that the longer an agent abstains from choosing a particular option, the greater the probability of avoiding the alarm from going off for that response. Under these circumstances, the optimal decision-making strategy is pressing R1 in 70% of trials and R2 in 30% of trials. Each block will have 50 trials. After each block participants will be asked multiple choice questions. The learning criterion consisted of correctly reporting the association between the two responses and the two outcomes two times in a row. Instrumental blocks will continue to be repeated, before moving to the next phase, until the learning criterion is reached. Participants will play atleast 2 blocks, even if they respond correctly after the first block. If 8 blocks are completed and the learning criterion is not reached, the task is terminated.

**2nd Phase: Pavlovian phase**

In the Pavlovian learning phase, participants learned associations between six conditioned stimuli (CSs), three social cues (animated characters with speech bubbles) and three non-social cues (fractal images), and three corresponding outcomes. Each trial began with a 5000 ms inter-trial interval (ITI), during which an empty control panel with a blank central space was displayed. Following this, one social and one non-social cue were presented together in the center of the panel for 5000 ms. For two of the cue pairs, 80% of the trials resulted in an aversive outcome (O1 or O2), consisting of a negative image paired with a loud noise, mirroring the outcomes used in the instrumental phase. In the remaining 20% of these trials, the outcome was an averted symbol accompanied by silence. The third cue pair (CS-) was always followed by the averted symbol and no noise. The outcome appeared below the control panel for 1000 ms while the cues remained on the screen. No levers were shown during this phase.

Each block consisted of 30 trials (i.e., 10 trials for each CSs). Blocks are followed by multiple-choice questions with the outcomes presented and the participants will be asked which cues predict this outcome, to ensure that all CS-outcome associations were correctly established. The learning criterion consisted of correctly reporting the association between the three CSs and the three outcomes two times in a row. Pavlovian blocks will continue to be repeated, before moving to the next phase, until the learning criterion is reached. Participants will play atleast 2 blocks, even if they respond correctly after the first block. If 8 blocks are completed and the learning criterion is not reached, the task is terminated.

**3rd Phase: Transfer phase**

The transfer phase is designed to test the influence of social and non-social Pavlovian cues on decision-making. The empty control panel appears for an ITI of 500-1500 ms. The social or the nonsocial Pavlovian cues CS+1/CS+2/CS- appear in the middle of the control panel along with the two levers below the control panels. The participants have 2000 ms to respond. If they don’t respond, similar to the instrumental phase, they will receive the 3rd aversive noise.

The transfer phase occurs without extinction. After each choice, the corresponding outcome appeared below the control panel for 1000 ms. Importantly, the probability of obtaining rewards was the same as the instrumental learning phase (i.e., 70% by choosing R1, 30% by choosing R2, with the insertion of the same baiting rule), and the CSs were irrelevant for the task. Hence, the optimal decision-making strategy still consisted of pressing R1 in the 70% of trials and R2 in the 30% of trials, independently of the CSs. The transfer phase consisted of a single block composed of 30 trials for each CSs and 30 trials for the “No cue” condition (i.e., no CSs appear simultaneously with levers, equal to the instrumental learning phase), trials interleaved, for a total of 210 trials.

**Task instructions:**

Welcome to the Alarm Control Simulation!

You are a technician responsible for monitoring and managing a highly sensitive alarm system in a secure facility. Your job is to minimize system malfunctions by responding to visual signals and colleague alerts that may indicate the potential activation of disruptive alarms (e.g., loud noises and visual alerts). Stay focused!

*Instrumental phase instructions:*

In this phase, your role is to interact with the control panel to prevent system alarms from being triggered.

On each trial, a control panel will appear on the top of the screen with two levers on the bottom. There are two types of system alerts that will be activated if you are unable to stop it from activating. Each lever is associated with avoiding one type of system alert. You must choose between the left and right levers by pressing the “L” or “R” button on the button box, respectively.

Make your selection as quickly as possible to ensure smooth system operations. If you fail to respond in time, a high-priority alarm will go off.

Your choices influence whether an alarm goes off. Some levers are more effective than others at preventing system alerts.

After each choice, you’ll see whether the alarm was successfully avoided (“Alarm turned off”) or triggered (a warning image and loud noise). Pay attention and try to learn which lever is more effective at preventing which alarms.

If you stop choosing a lever for several trials, its chance of successfully preventing an alarm may improve—so consider varying your responses strategically.

After each block of trials, you will answer a few questions to test your understanding of how the system works. You’ll continue playing blocks until you've demonstrated you understand the pattern of outcomes.

*Pavlovian phase instructions:*

In this phase, your task is to observe system alerts and learn which signals predict malfunctions.

On each trial, you will see two types of alerts: Sensor alerts (fractal symbols) and Coworker alerts (speech bubbles from a colleague). These alerts appear together in the center of the control panel.

After a short delay, you may experience a system malfunction (an warning image with a loud noise) or a message indicating the system remained stable.

You do not need to press anything during this phase. Just watch and try to learn which alert pairs tend to predict system failures.

At the end of each block, you'll answer questions to test your memory of which alerts were followed by which outcomes. You will continue to the next phase once you have correctly learned these associations.

*Transfer phase instructions:*

Now it’s time to combine what you’ve learned.

In each trial, you will again see the control panel and two levers, just like in the first phase.

Occasionally, one of the alerts from the previous phase (a sensor or coworker alert) will appear in the center of the screen along with the levers.

Your goal is to continue making the best lever choices to avoid alarms, just like you did in the first phase.

If you fail to respond in time, a disruptive alarm will be triggered. Try to make choices based on your experience managing the levers.

Sometimes the alerts are helpful, but sometimes they are misleading. Your goal is to learn the best lever responses to avoid system failures while also interpreting the warning signals when they appear.