**Probabilistic Learning Task**

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The Probabilistic Learning task has been created as a replication of the task presented in the paper by **Frank, Woroch and Curran (2005).** The task is based on the assumptions of reinforcement learning and adapted to be used for both behavioural and neurophysiological assessments. It was designed using the PsychoPy3 Experiment Builder v3.1.0. The main adaptation compared to the original paper includes the change of feedback. Originally, Frank et al., used smiley faces and crosses to indicate correct and incorrect responses. Here participants receive a green “+10” when the correct response is made, and a red “-10” when an incorrect response is made. There are also a few trials added to monitor participant learning.

**Contents:**

**1……………………..………………………………………………………………………. EXPERIMENT OUTCOMES**

**2…………………………………………………………………………………………………….EXPERIMENT DETAILS**

**3……...........………………………………………………………………………..………………..…DATA ANALYSIS**

**4……..........……………………………………………………………..………………..ADDITIONAL MATERIALS**

**5……………………………………………………..… HOW DO I USE THE TASK IN MY OWN RESEARCH?**

**6. ………………………………………………………………………………….…………………………...REFERENCES**

1. **EXPERIMENT OUTCOMES**

The timing of the components and stimuli in the task allows for the analysis of a range of variables including behavioural and electrophysiological data. In its current form, the task allows to measure:

**Behavioural outcomes:** win-stay and lose-switch behaviours, learning rates (based on the performance criterion), task accuracy divided into positive and learning bias during the learning phase.

**Electrophysiological**: ERPS: ERN, FRN.

1. **EXPERIMENT DETAILS**

**Task sessions:**

PRACTICE SESSION: the aim of this session is to help participants understand the task before they proceed onto the training session. The session contains 10 trials.

TRAINING SESSION: the aim of this session is to learn (via reinforcement learning) which symbols are more likely to give positive feedback. There are 3 pairs of symbols with different probabilities. Participants receive feedback on their choices. The session contains 60-180 trials and uses a performance criterion before the participants can progress.

TESTING SESSION: in this session there is no feedback and new stimulus pairs are constructed. Participants should go with their instinct to choose the symbols which are the most likely to give positive feedback.

**Trials:** In each trial there are two Japanese hiragana symbols presented on the screen. The position of the characters is randomised. Participants are instructed to choose just one symbol by pressing the button “c” or “m” on a computer keyboard. Participants are instructed that their goal in the task is to collect as many points as possible. Some symbols are more likely to give points and some symbols would lead to losing points.

In the practice session, each trial starts with a fixation cross for 500ms. Subsequently, a pair of symbols appears for a maximum of 1500ms or until the participant makes a response. Participants receive feedback in the form of green “+10” or red “-10” which is presented on the screen for 600ms. If participants make no response the message “no response detected” appears. There are only 10 trials during this session. All trials show the same pair of symbols. One of the characters in the pair had 80% probability of showing the “+10” feedback and thus 20% probability of showing the “-10” feedback. Following this session, participants see more instructions screen which explain the task based on the example of the practice. It is emphasised that there is always one symbol in a pair that has a higher PROBABILITY to give points.

The training session resembles the short practice but includes 3 pairs of hiragana characters. Additionally, the fixation period is jittered between 300 and 800 ms and following each the response, a blank screen is shown for 350ms before the feedback is presented. This is to make sure that the ERN and FRN can be measured without overlap. Feedback is presented for 600ms. The first pair of symbols (AB) has a 80%/20% probability split for letter A (80%) to provide positive feedback and letter B (20%) to provide positive feedback. The second pair (CD) has a 70%/30% probability split for letter C (70%) and letter D (30%) to provide positive feedback. The last pair (EF) has a 60%/40% probability split for letter E (60%) and letter F (40%) to provide positive feedback. Participants learn throughout this session to choose the letters that give them points and avoid the letters that make them lose points. Each training session has a requirement for at least 60 completed trials in whith and established performance criterion. To reflect that participants have learnt the letters accurately, letter A must be selected 70% of the time, letter C 60% of the time and letter E 50% of the time. If participants cannot reach the learning criterion, they can only complete a maximum of 180 trials in each training session.

During the testing session, participants are shown pairs of the same symbols but in new combinations. They are asked to pick the symbols that are most likely to give them positive feedback. The session consists of a fixation cross jittered for a duration of 500 to 1000 ms. The pair of symbols are shown for 1000ms which is the time during which participants can make a response, although each response terminates the trial. There is no feedback presented. There are 92 trials within each testing block, each pair including character A and character B (apart from AB) is presented 8 times, all other pairs are presented 4 times. This is because the learning bias and ERN will only be studied on the pairs with A and B characters. To test whether participants have correctly identified symbols A (the most probable positive feedback) and B (the least probable positive feedback), there are two learning check trials at the end of this session. Participants are asked to use numbers 1-6 on the keyboard to indicate which symbols out of all 6 that were used in the task, were the most and least likely to give them positive feedback.

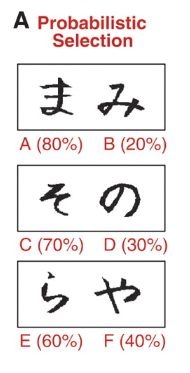
**Conditions:** There are no conditions in this task. The learning and testing phases are repeated three times. A different set of symbols is randomly assigned each time. However, there are only 3 sets of stimuli available for each participant so each person completes the task on the same stimuli but in random order.

1. **DATA ANALYSIS**

**Analysis scripts**: Analysis scripts have not yet been made available. If you would like to ask about this please drop me an email.

1. **ADDITIONAL MATERIALS**

Below is the diagram produced by Frank, Woroch and Curran (2005) to illustrate the stimuli probabilities during the learning phase.



1. **HOW DO I USE THE TASK IN MY OWN RESEARCH?**

You will need to have PsychoPy installed on your computer. Please note that the experiment was created in PsychoPy3 Experiment Builder v3.1.0 and some features may run differently in a more recent version (however, it is not recommended that you install the old version just to be able to work on the task).

Make sure to download all files from my GitLab repository apart from the folder “data”.

The file “Probabilistic Learning.psyexp” should let you open the experiment in PsychoPy. From this point you can make your own changes to the task and adapt it so that it becomes suitable for the needs of your experiment.

**Added Code:** The code components that are added in this task include specification for jitter used to randomise the inter trial intervals (ITI). There is also a component which specifies the given feedback. Additionally, a very important part of the code specifies the performance criterion which allows participants to progress to the testing phase if the conditions have been met.

**Condition files:** You might notice that there are many condition files and loops in the task. The main loop which uses the condition file letterchoice.xlsx is a directory to all the other condition files divided into 3 groups. Group one is used for the learning session, group 2 is used for the testing session and group 3 is used for the learning check immediately after the testing session.

**Referencing the task:**

Topor, M. (2021). Probabilistic Learning Task [Experiment Code]. Retrieved from: <https://gitlab.pavlovia.org/Topor/probabilistic-learning-task>, DOI: 10.5281/zenodo.4514477

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1. **REFERENCES**

Frank, M. J., Woroch, B. S., & Curran, T. (2005). Error-related negativity predicts reinforcement learning and conflict biases. *Neuron*, *47*(4), 495-501.