

# The Titration Experiment

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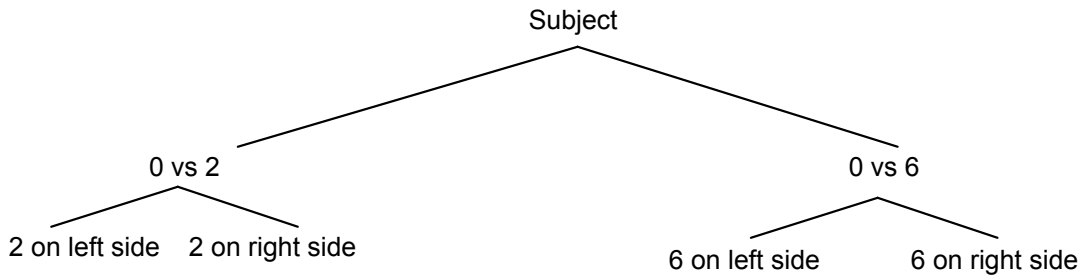
**Goal:** The goal of the titration experiment is to quantify a discount rate for two species of New World monkey (tamarins and marmosets) and estimate a curve describing how each species of monkey devalues food over time. Previous experiments have determined such a function in pigeons, rats and macaques (Mazur 1987, Tobin and Logue, 1994) using a titration procedure (Mazur, 1987). A titration procedure involves subjects choosing between a small, immediate reward and a larger, delayed reward. The delay to the larger reward is adjusted until the subject is indifferent between choosing the smaller and the larger reward. A curve of such indifference points will indicate how impulsive each subject is.

## Method:

**Subjects:** Subjects will be cotton-top tamarins (*Saguinus oedipus*) and common marmosets (*Callithrix jacchus*) from the Primate Cognitive Neuroscience Laboratory at Harvard University. Subjects were born at the New England Regional Primate Center, Southborough, Massachusetts or in the laboratory. All subjects participate in other behavioral experiments. Tamarins are maintained at 95% of their ad libitum weights.

**Materials:** Each subject will be removed from their homecage and taken into a testing room in a transport cage. The front of the transport cage will be Plexiglas and have two openings through which the subject can reach for food. The front barrier also has two lower openings through which two L shaped tools may slide on either side. These tools allow the subject to make a choice between the two rewards by pulling forward the appropriate tool handle. Plexiglas barriers cover the tools while the subject chooses and waits for their reward. Once the subject has chosen one tool, the other will be removed out of reach. In the case that the subject picks the large reward tool, the experimenter will initiate a delay when the subject pulls the tool fully to the front Plexiglas. After the delay (or when the subject has fully pulled the small reward tool to the Plexiglas) the tool barrier will open and the subject will be able to reach for the reward.

**Procedure:** Each subject will be run through several stages of training before being put in a testing situation. The first training is for colour association and is done with clear barriers. An orange tool always delivers the small reward (2 banana-flavoured primate pellets) while a green tool always delivers the large reward (6 pellets). A white tool delivers no reward. In each session, a subject will experience two colour choices (orange vs. white and green vs. white) and each choice is presented on both sides. The experimental design for the colour training is therefore a within-session 2 x 2 design. Each of these combinations will be repeated 4 times, to give a session of 16 trials. Criteria for passing the colour training will consist of the subject choosing the white tool no more than once a session and each subject must pass two colour sessions consecutively.



**Figure 1:** Colour training. Each trial is repeated 4 times, totaling 16 trials per session.

The second stage consists of determining the preference for each subject in a choice between the small reward and the large reward when no delay is associated with either choice. These sessions are run identical to the testing sessions and will also be run with the clear barriers. Each session begins with 4 trials of forced choice and 2 trials of colour choice. A forced trial is one in which only one choice is offered (either the orange tool or the green tool). These are included in order to expose the subject to the contingencies for both rewards in each session. A colour choice trial is similar trial as those in the colour training sessions. The white tool is offered as a choice once with the green tool and once with the orange tool. These trials are included to establish that the subject is paying attention to the rewards on both sides. Tools will not change sides during a session, but will alternate between sessions. Once a subject has passed the initial 6 trials of a session, 10 free choice trials will follow in which both small and large rewards are offered. Each subject must run a minimum of 6 sessions of preference testing and must pass the last 4 sessions consecutively. To pass a session, a subject must pull both forced choices, not pull the white tool in either trial and pull for the large reward 9 or 10 times out of the 10 free choice trials.

The final stage of this experiment will consist of the titration procedure. Each subject will experience choice between the small reward (2 pellets in the orange tool) and the larger reward (6 pellets in the green tool). Sessions will consist of 4 forced trials (two of each tool) and 10 free choice trials. One of each forced trial will initiate each session, while the other two will be randomly placed within the session. The initial series will consist of no delay associated with the small reward, while the delay on the large reward will change according to subject preference. Each subject will start with a 1s delay on the large reward. If the large reward is picked more than 7 out of 10 free choice trials, then the large delay is increased by 1s. Similarly, if the small reward is picked more than 7 out of 10 free trials, then the large delay is decreased by 1s. Sessions will continue according to this criteria until subjects are indifferent between the choices. Such an indifference point will be established when the following criteria are met: a) neither the highest nor the lowest large-reinforcer duration can occur in the last six sessions b) the mean adjusting delay across the last six sessions can not be the highest or the lowest six session mean and c) the mean delay of the last six sessions can not differ from the mean of the preceding six sessions by more than 10% or more than 1s (whichever is larger). If time permits, delay on the small reward will be increased and the titration procedure repeated in the new condition.