

Adaptive Staircase Method

PSY310: Lab in Psychology

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GitHub Link: <https://github.com/AahnaS/Adaptive-Staircase>

Introduction:

Adaptive Staircase is a psychophysical method introduced by Tom Norman Cornsweet in 1962. This method is used to determine absolute and difference thresholds by repeatedly presenting a variable stimulus and adjusting it based on whether it is perceived or discriminated from a standard stimulus. Its algorithm follows the three-up-one-down and is also called the up-and-down method. This method is used by optometrists when determining if an individual requires glasses. They begin with a chart which has letters from large to small. When the individual fails to read a letter, the optometrist goes one step back and asks if the slightly bigger letter is visible. The exact process is repeated when another error occurs (reversal), finally leading to a threshold value.

Alternative methods:

- 1) Method of Adjustment (the method is based on the observer's subjective judgment and relies on their ability to continuously adjust a specific stimulus parameter until they detect the change);
- 2) Bayesian Adaptive Procedure (It uses Bayesian statistical principles to dynamically select and adjust stimuli based on an observer's responses, aiming to minimise the number of trials, incorporating prior knowledge and adapting to individual performance)-the quick Change Detection (qCD) method.

Method:

The adaptive staircase experiment was conducted using PsychoPy. The idea was to find a threshold when the participant, in this case, self to find the grating's tilt (left or right). The experiment was constructed by adding a fixation, here, a cross, grating mentioning the number of trials in terms of appearance, adding a key response to input the correct answer, followed by the code for beginning and ending routine and inserting a loop for the same.

This experiment has a total of 49 trials.

The sequence of the events is as follows- a black dialogue box appears, followed by a cross (as chosen from the polygon stimuli), and then contrast grating appears on the screen. It has the

orientation of the grating is set every repeat mode. The grating either tilts to the left or the right. It shows for a duration of, and the participant is expected to identify the tilt of the grating and either respond by pressing the left or the right arrow key. After pressing the arrow key, the next tilted grating appears for 0.3 seconds. After the successful completion of trials, the dialogue box promptly disappears.

The subject's main task was to press the arrow keys based on their identification, whether the grating is tilted more towards the screen's left or right side.

The data results were exported by psychoPy to an Excel file. It depicted the responses using binary, 0 indicating wrong and 1 indicating the correct answer. The tilt of the grating is mentioned, and the right direction, which is the correct answer in this case, is also stated. This information would calculate the mean of the last ten variables to determine the threshold. Another way could be to take the mean of the reversal or the last tilt value. As it was simple data with only a single participant, no additional steps were taken to determine the final value of the threshold.

Results:

The table shows the last 10 data points out of the 49 trials conducted.

The average of the last ten data points-

Tilt	Key Response (correct or wrong)
-1	1
1	1
1	1
1	1
-1	1
-1	1
-1	1
1	1
1	0
1.5	1

The threshold value for the adaptive staircase experiment is 0.31818.

The tilt's direction is smaller and difficult to gauge after the participant gives consecutively correct answers. On the same line, if the participant cannot identify direction, the tilt is more visible.

Discussion-

The staircase procedure has certain limitations- The adaptive staircase method depends solely on the observer's responses and judgments, which can be influenced by biases that can affect the threshold. For example, if the participant suspects of getting consistently wrong answers, frustration might creep in, hindering the actual results.

Another limitation would be that it assumes that the participant's ability to perceive or discriminate stimuli remains the same throughout a block of trials. This assumption can be problematic when perceptual sensitivity is changing. This, in turn, makes the threshold obtained biased.

Nonetheless, based on the references, the adaptive staircase method is still a popular method that is widely used and has developed over time, making it suitable for experiments by researchers.

References:

Staircase method. (n.d.). Oxford Reference.

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Zhang, P., Zhao, Y., Doshier, B. A., & Lu, L. (2019). Evaluating the performance of the staircase and quick Change Detection methods in measuring perceptual learning. *Journal of Vision*, 19(7). <https://doi.org/10.1167/19.7.14>