Adaptive Psychophysical Methods (*cont.*)

Outline

- Simple Up-Down Method (also known as Staircase Method)
- Transformed Up-Down Methods
  - Overview
  - **The 3-interval 1-up 3-down Method**
- **Interleaved Adaptive Methods**
  - **Double-Random Staircase (i.e., interleaved simple up-down method)**
  - **Interleaved 3I 1-up 3-down method**

The Three-Interval One-Up Three-Down Method

- There are three stimulus presentations per trial
  - Two of the intervals contain the reference stimulus
  - One randomly-selected interval contains the test stimulus
  - Subject's task is to indicate which interval (1, 2 or 3) contains the signal that is *different*
- The level of the reference is kept constant
- The difference between the test and reference is increased after one incorrect response
- The difference is decreased after three successive correct responses
- This method is both efficient and robust (see Leek, 2001)
- The threshold corresponds to the 79.4%-percentile point on the psychometric function. *Why?*

Question for Discussion:

How To Run a 3I 1-up 1-down Detection Experiment?

Demo of 3-I 1-up 3-down Method

- Go to course website:
  http://shay.ecn.purdue.edu/~ece511/
- Click on "Online Experiments"
- Scroll down to "Part III. Adaptive Methods"
- Select the third bullet "Line-Length Discrimination (3IFC)"
- Run yourself

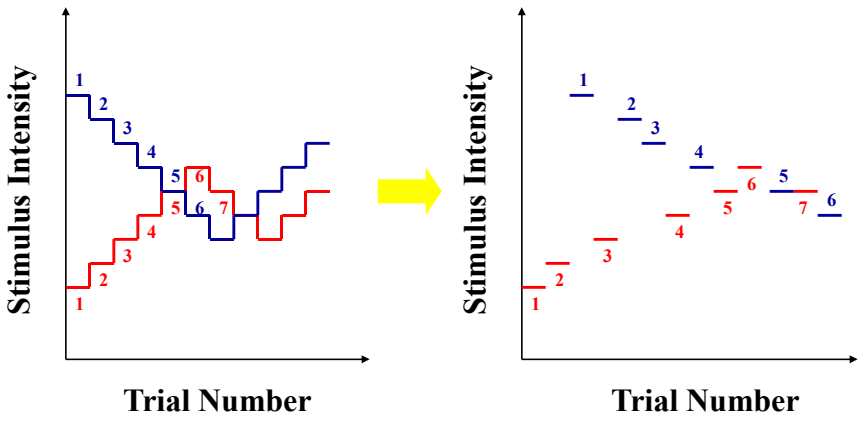
Interleaved Adaptive Methods

- To eliminate the response bias that is inherently present in the staircase method, the experimenter interleaves two or more staircase sequences by randomly assigning trial numbers to the sequences. As a result, the subject can no longer reliably keep track of the direction (increase or decrease) along which stimulus intensity will vary.

Double-Random Staircase

- This is an example of interleaving two simple up-down sequences.
- One of the sequences is an *ascending* one, and the other *descending*.
- On each trial, one of the two sequences is randomly selected by a computer program.
- The stimulus level is based on the subject's previous responses to trials belong to the selected sequence only.
- The experiment ends when both sequences have been completed.

The Idea

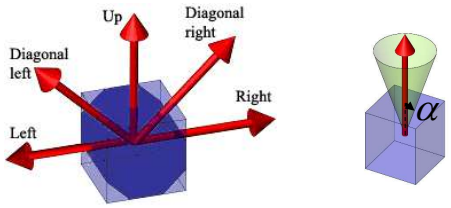


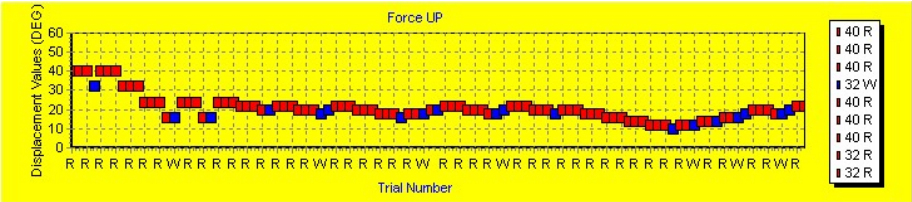
Interleaved 3I 1-Up 3-Down Method: *Force-Direction Discrimination*

- In this example, five (5) conditions corresponding to five reference-force directions were interleaved. On each trial, one of the conditions is selected with equal probability (0.2).
- This method also equalizes/eliminates *training effects* for the multiple conditions.

Method

- Independent variable α is the angle between F_{ref} and F_{test}
- The participants' task was to indicate the odd force direction from amongst three forces (F_{ref} twice, F_{test} once, in randomized order) presented in each trial





(Threshold = 18.8°±1.9°)

- **Initial Δα (difference in direction between F_{ref} and F_{test}) was 8°, for quick *convergence***
- **Δα was reduced to 2° after the first five reversals, for better *accuracy***
- **The sequence was terminated after 12 reversals at 2°**
- **Threshold is computed as the average of the peaks & valleys at the last 12 reversals**

References

- Chap. 11: Macmillan, N.A. & Creelman, C.D. (2001). *Detection Theory: A User's Guide*.
- Federico Barbagli, Kenneth Salisbury, Cristy Ho, Charles Spence, and Hong Z. Tan, "Haptic discrimination of force direction and the influence of visual information," *ACM Transactions on Applied Perception*, Vol. 3, No. 2, pp. 125-135, 2006.