

Adaptive Psychophysical Methods

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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

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What Do We Mean by “Adaptive”?

- The stimulus intensity level on any one trial is determined by the preceding stimuli and responses
- *Do we already know any adaptive method?*

Why Adaptive Method?

- Compared with other methods (e.g., constant stimuli, signal detection), adaptive method places most of the stimuli at intensity levels close to the threshold that is being measured
- Adaptive method allows for more *efficient* estimation of thresholds

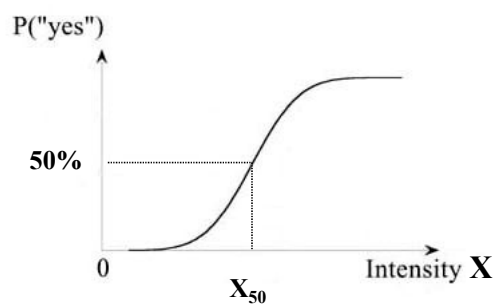
Simple Up-Down Method (Staircase Method)

- Adaptive methods reduce the number of trials at the stimulus intensity levels at which the proportion of responses YES is close to zero or close to one.
- Staircase method is analogous to the method of limits, *except that*
 - ◆ an ascending (descending) sequence does not terminate after the first reversal from NO to YES (YES to NO) response.
 - ◆ Instead, the experiment continues until many reversals are obtained around the value to be estimated.

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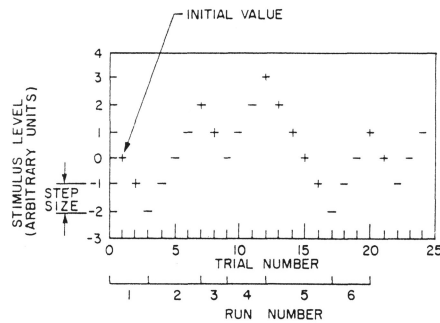
- The simple staircase method estimates the 50% point of the psychometric function.



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Data Analysis (Staircase Method)



- The concept of *initial value*, *step size*, *run*
- Estimate of X_{50} : midpoint of every 2nd run; or equivalently, average of peak-valley pairs.

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Discussion of the Simple Up-Down (Staircase) Method

- Advantage
 - ◆ Most stimulus intensity levels are placed around X_{50}
- Disadvantage
 - ◆ Difficulty with steps that are too small (takes forever) or too large (low precision)
 - ◆ Can't estimate levels other than X_{50}
 - ☞ Solution: Transformed Up-Down Methods
 - ◆ Subject can anticipate the stimuli and adjust responses accordingly
 - ☞ Solution: Double-Random Staircase Method

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Adaptive Step Size

- At the start of an experiment, a large step size is used
- The step size is gradually decreased during the course of the experiment
 - ◆ Robbins and Monroe (1951): c/n (c : constant, n : trial number)
 - ◆ Half the step size after a fixed number of trials
- When in doubt, aim at a larger initial step size
 - ◆ Efficiency is reduced by 25% if initial step is twice the optimum value
 - ◆ Efficiency is reduced by 100% if initial step is half the optimum value.

Transformed Up-Down Methods

- Transformed methods are used to estimate percentile points other than 50%. The stimulus level is increased or decreased after specific sequences of stimuli and responses.

Comparing the Simple and Two Transformed Up-Down Methods

	Simple	Transformed (70.7% percentile) 1-up 2-down	Transformed (84.1 percentile) 1-up 4-down
Increase Level after	-	+ - or -	+++ - or ++ - or + - or -
Decrease level after	+	++	++++
P(UP)=P(DOWN)=.5	P(X)	[P(X)] ²	[P(X)] ⁴
P(X)	0.5	0.707	0.841

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Readings

- **Chap. 11: Macmillan, N.A. & Creelman, C.D. (2001). *Detection Theory: A User's Guide*.**
- **Levitt, H. (1971). Transformed Up-Down Methods in Psychoacoustics. *The Journal of the Acoustical Society of America*, 49(2), 467-477.**

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