FACULTY OF ARTS
Charles University

Department of psychology

Psychophysics

Adaptive methods

Today

- Up/Down methods
- “Running fit” methods
- PsychoPy

Up/Down method - intro

- Dixon & Mood (1948) - explosions
- If both responses are of the same probability

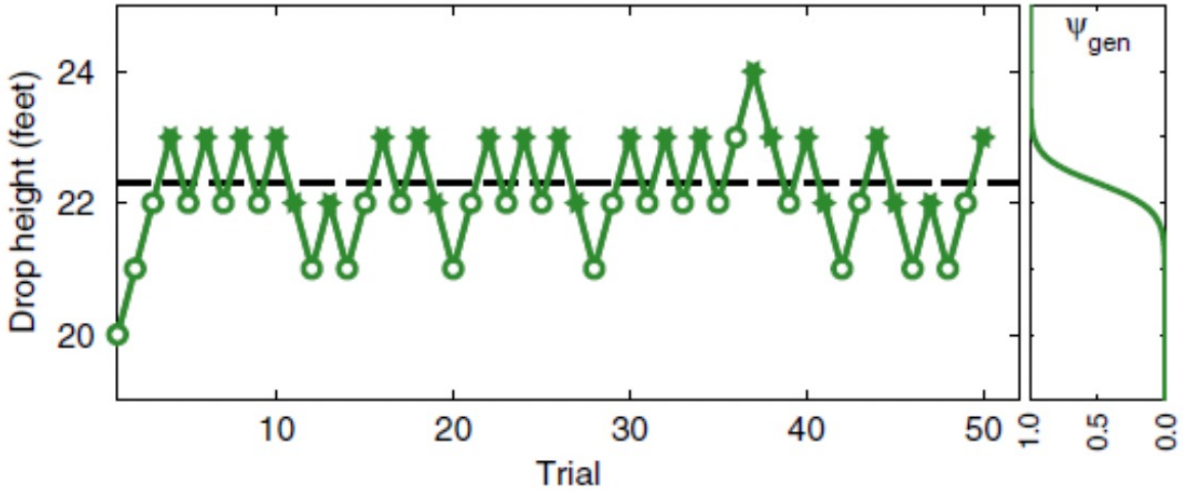


FIGURE 5.1 Simulated run of the up/down method of Dixon and Mood (1948). The figure follows the example described in the text. Weights are dropped from various heights (ordinate) on explosive mixtures. If an explosion occurs (filled symbols) the drop height is reduced by 1 foot on the next trial, and if no explosion occurs (open circular symbols), the drop height is increased by 1 foot. The targeted height (22.3 feet) is indicated by the broken line. Responses were generated by a Logistic function with $\alpha = 22.3$, $\beta = 5$, $\gamma = 0$, and $\lambda = 0$. The generating function (ψ_{gen}) is shown on the right.

Up/Down method - variants

- *If both responses are of the same probability…*

- Good for PSE, but in many tasks 50% = guessing (2AFC)
- We use different steps (we approach a different level, not 50%)
- **“transformed”**

  We include more preceeding trials

  1 up/2 down (70.71%), 1 up/3 down (79.37%)

  We start with 1u/1d and change the schema after first “reversal”
- **“weighted”**

  steps “up” and “down” of different size

Weighted Up/Down - examples

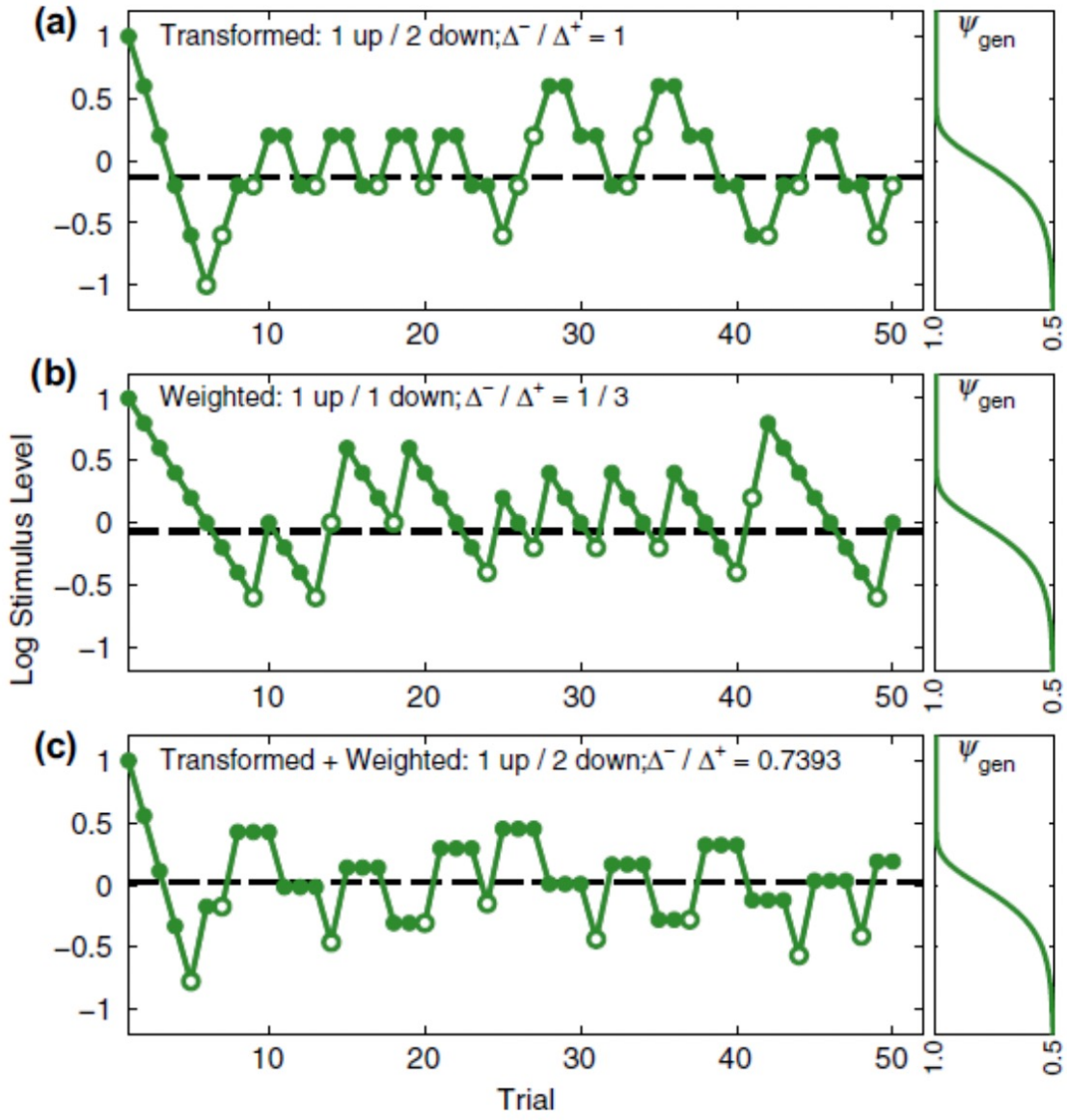


FIGURE 5.2 Examples of simulated staircases following a transformed up/down rule (a); a weighted up/down rule (b); and a transformed and weighted up/down rule (c). Correct responses are indicated by the filled symbols, and incorrect responses are indicated by open symbols. Stimulus levels corresponding to the targeted percent correct values are indicated by the broken lines (note that the different procedures target different performance levels). In all example runs the responses were generated by a Gumbel function with $\alpha = 0$, $\beta = 2$, $\gamma = 0.5$, and $\lambda = 0.01$. The generating PF (ψ_{gen}) is shown to the right of each graph. Δ^+: size of step up; Δ^-: size of step down (see Section 5.2.3).

Weighted Up/Down

- Target probability of correct response ψ_{target}
- $\psi_{target} = \Delta_+ / (\Delta_+ + \Delta_-)$
- It means $\Delta_- / \Delta_+ = (1 - \psi_{target}) / \psi_{target}$

- Example

  We want to estimate value for $\psi_{target} = 75\%$

  $\Delta_- / \Delta_+ = (1 – 0.75) / 0.75 = 1/3$

Transformed and Weighted

- Both approaches can be combined
- Number of correct responses for step down D

- $\Psi_{target} = (\Delta_+ / (\Delta_+ + \Delta_-))^{1/D}$

Time to finish?

- After fixed number of reversals
  - result = average of last X reversal values
  - example: finishing after 10 reversals, calculate average of last 8 reversals
- After fixed number of trials (less common)
  - example: collecting 50 trials, calculate average of last 10 trials
- “hybrid adaptive procedure”
  - After collecting data we fit PF curve
  - Minus: There are more assumptions (shape, guess, lapse)
  - Staircase expects only monotonous relationship
  - Intensity chosen for threshold measurements, not for slope

Multiple sequences

- *A series of consecutive lucky guesses is followed by one or more trials on which I also feel like I am guessing. This continues until I give a few incorrect responses.*

- sequence (run)

  Usually multiple simultaneously to hide the mechanism

Result in multiple runs

- For each run separately, then calculate average. SD shows reliability of the measurement
- We pool the data and fit PF curve, reliability with bootstrap

Examples

TABLE 5.1 Ratios of down stepsize and up stepsize Δ^-/Δ^+ that will reliably converge on the targeted ψ values given by Eqn (5.2); these values are suggested by García-Pérez (1998) and are based on a large number of simulated runs.

Rule	Δ^-/Δ^+	Targeted ψ (%)
1 up/1 down	0.2845	77.85
1 up/2 down	0.5488	80.35
1 up/3 down	0.7393	83.15
1 up/4 down	0.8415	85.84

- Not all converge well (García-Pérez, 1998)
- How large steps?

  step up σ/2 to σ, where σ is spread PF
- Units – based on the task, to correspond to the linear changes in internal representation

  (Linear or logarithmic)

Running fit - Best PEST

- Pentland (1980)
- For thresholds (all other assumed)
- After each step we fit all values with PF curve
- Next intensity is the threshold of this PF curve

- You can see changes up/down after incorrect/correct responses
- Step sizes differ

QUEST

- Watson & Pelli (1983)
- Bayes version of PEST
- needs priors

Best PEST and QUEST

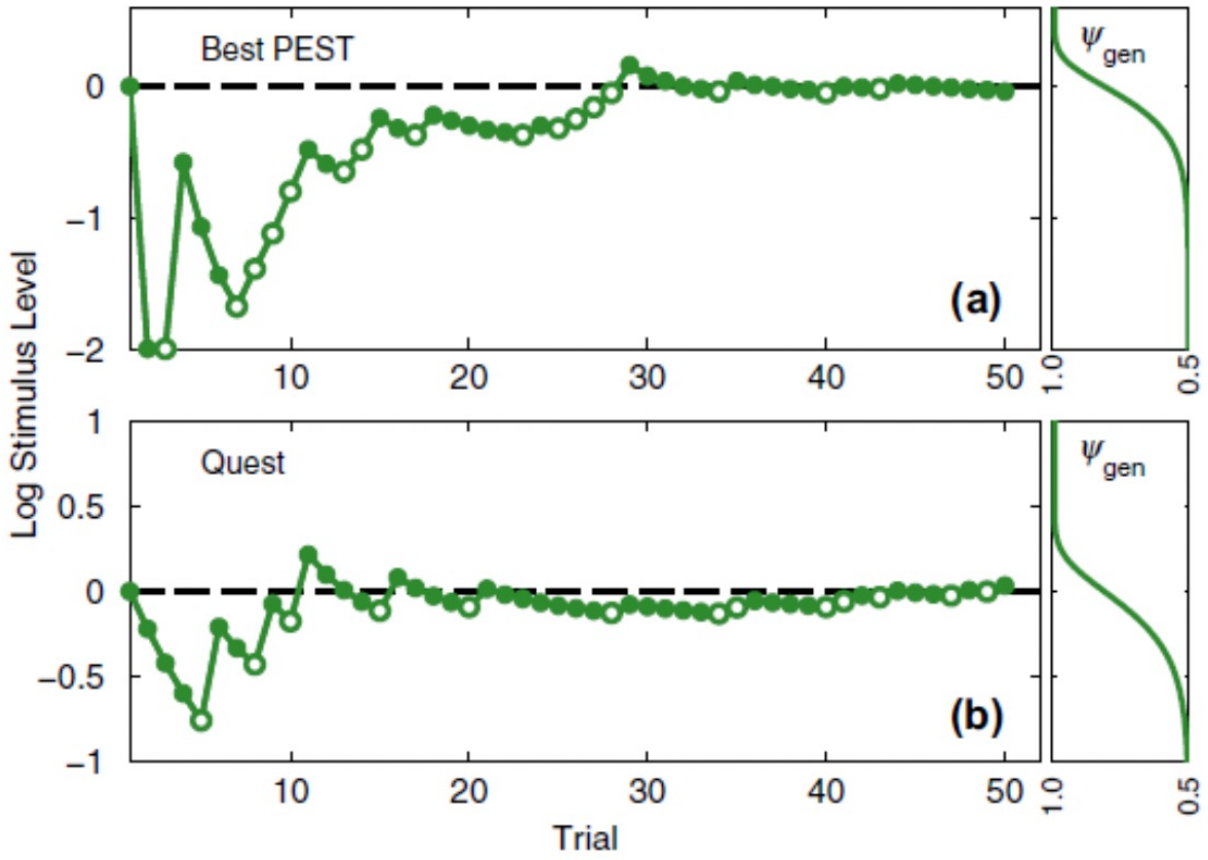


FIGURE 5.3 Examples of a simulated best PEST staircase (a) and a Quest staircase (b). Correct responses are indicated by the filled symbols, and incorrect responses are indicated by open symbols. Stimulus levels corresponding to the threshold of the generating PFs are indicated by the broken lines. In both example runs the responses were generated by a Gumbel function with $\alpha = 0$, $\beta = 2$, $\gamma = 0.5$, and $\lambda = 0.01$. The generating PF (ψ_{gen}) is shown to the right of each graph.

Time to finish?

- After fixed number of trials (60)
- After fixed number of reversals

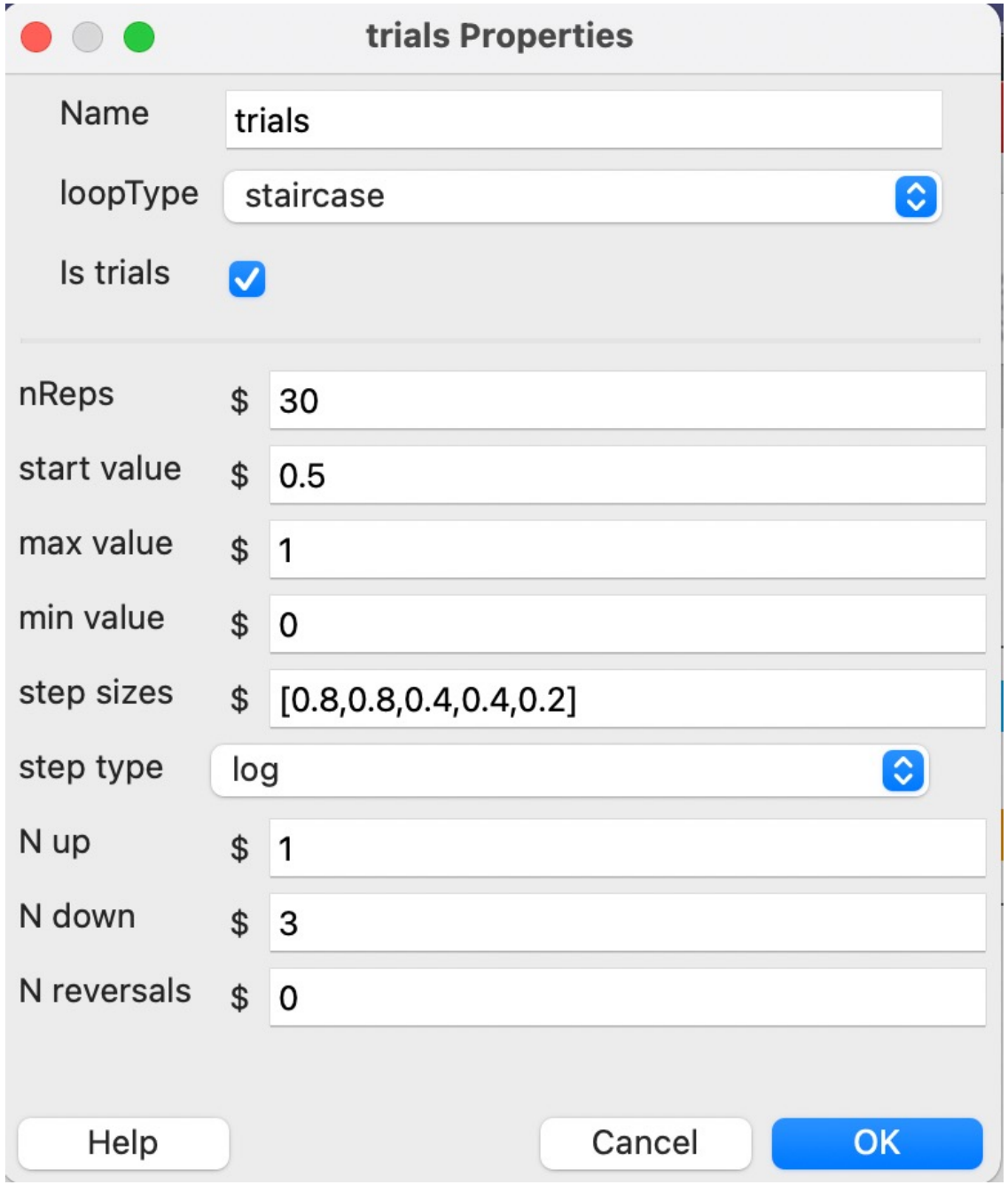
- Result = the last measured value
- Sometimes we omit priors for final evaluation

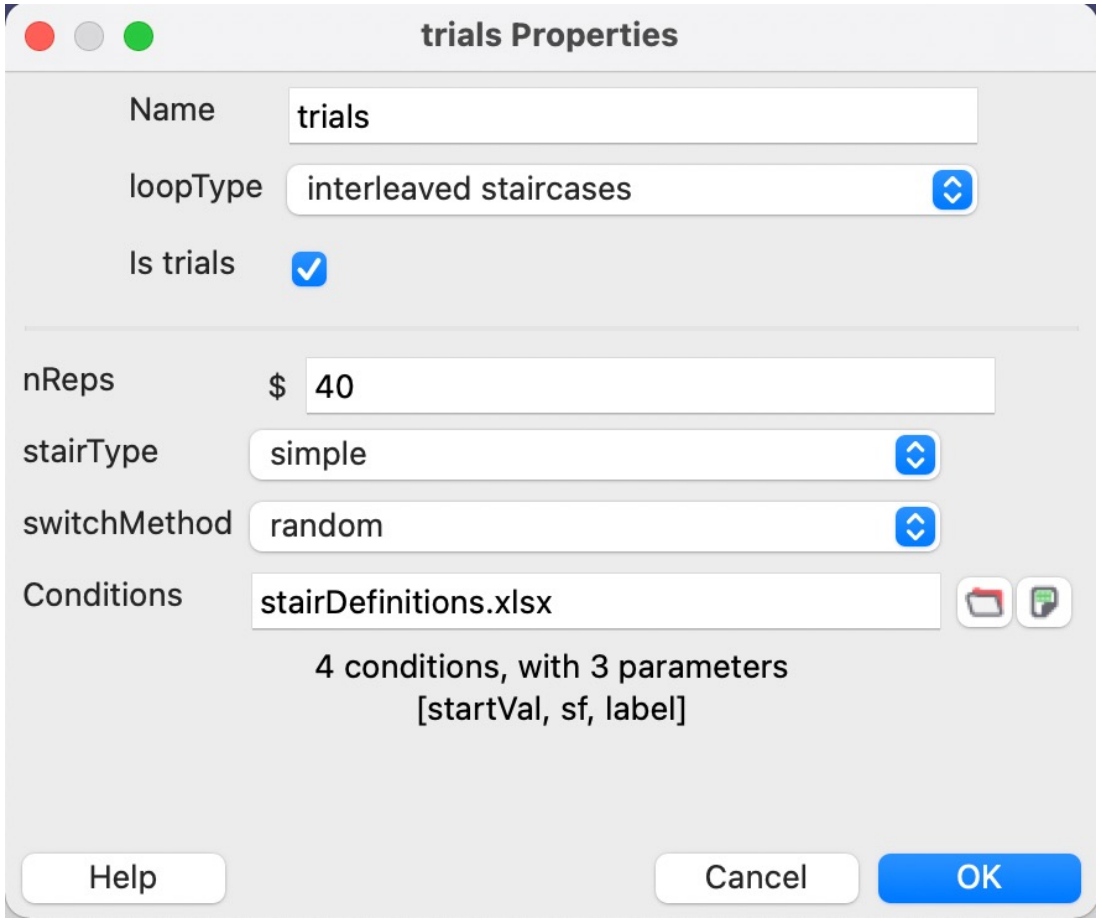
Practical considerations

- “parametric methods” – you must make assumptions
- We pretend we know everything, but the threshold...
- Methods are mostly robust to violated assumptions
- Too steep slope – small steps, difficult to compensate for random lucky guesses
- Allow lapse rate (0.02), otherwise lapse in easy trial is long remembered
- You do not have to “follow” recommended thresholds, you can choose differently
- Multiple runs
- Multiple sessions - recent posterior as new prior

Examples

- Demos > Design Templates > psychophysicsStaircase
- Demos > Design Templates > psychophysicsStairsInterleaved





	A	B	C	D	E	F
1	label	startVal	sf	stepSizes	maxVal	minVal
2	low_2	0,001	2	[4,2,2,1]	1	0
3	high_2	0,1	2	[4,2,2,1]	1	0
4	low_8	0,001	8	[4,2,2,1]	1	0
5	high_8	0,1	8	[4,2,2,1]	1	0
6						

Documentation

- http://www.psychopy.org/api/data.html#psychopy.data.StairHandler
- http://www.psychopy.org/api/data.html#psychopy.data.MultiStairHandler

- QUEST

  https://www.psychopy.org/api/data.html#psychopy.data.QuestHandler

  https://www.psychopy.org/api/data.html#psychopy.data.QuestPlusHandler