



FACULTY OF ARTS
Charles University

Department of psychology

Psychophysics

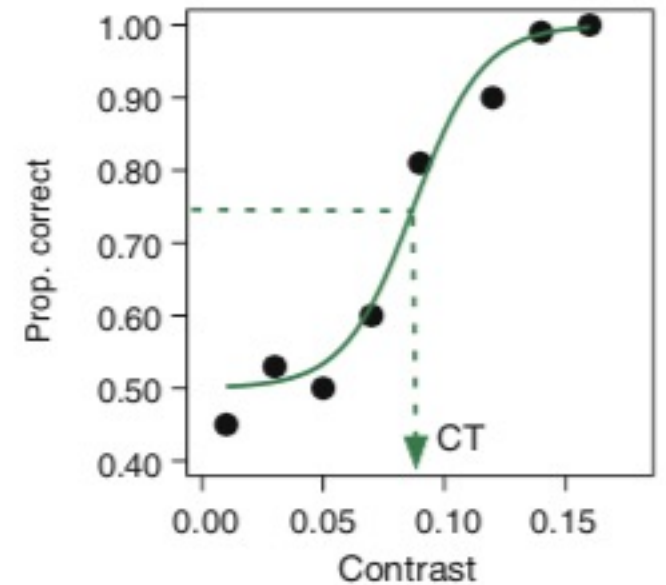
Methods

Terminology

- Stimulus - patch
- Task – single unit
 - 2IFC, adjustment
- Method – how tasks selected
 - „method of constants“, adaptive methods
- Analysis - calculations
 - Averaging, fitting psychometric curve
- Measure – what we measure
 - Contrast detection threshold



$$C = \Delta L / L_b$$



Dichotomies

- “Class A” versus “Class B” Observations
- “Type 1” versus “Type 2”
- **“Performance” versus “Appearance”**
- “Forced-Choice” versus “Nonforced-Choice”
- “Criterion-Free” versus “Criterion-Dependent”
- “Objective” versus “Subjective”
- “Detection” versus “Discrimination”
- “Threshold” versus “Suprathreshold”

Summary performance/appearance

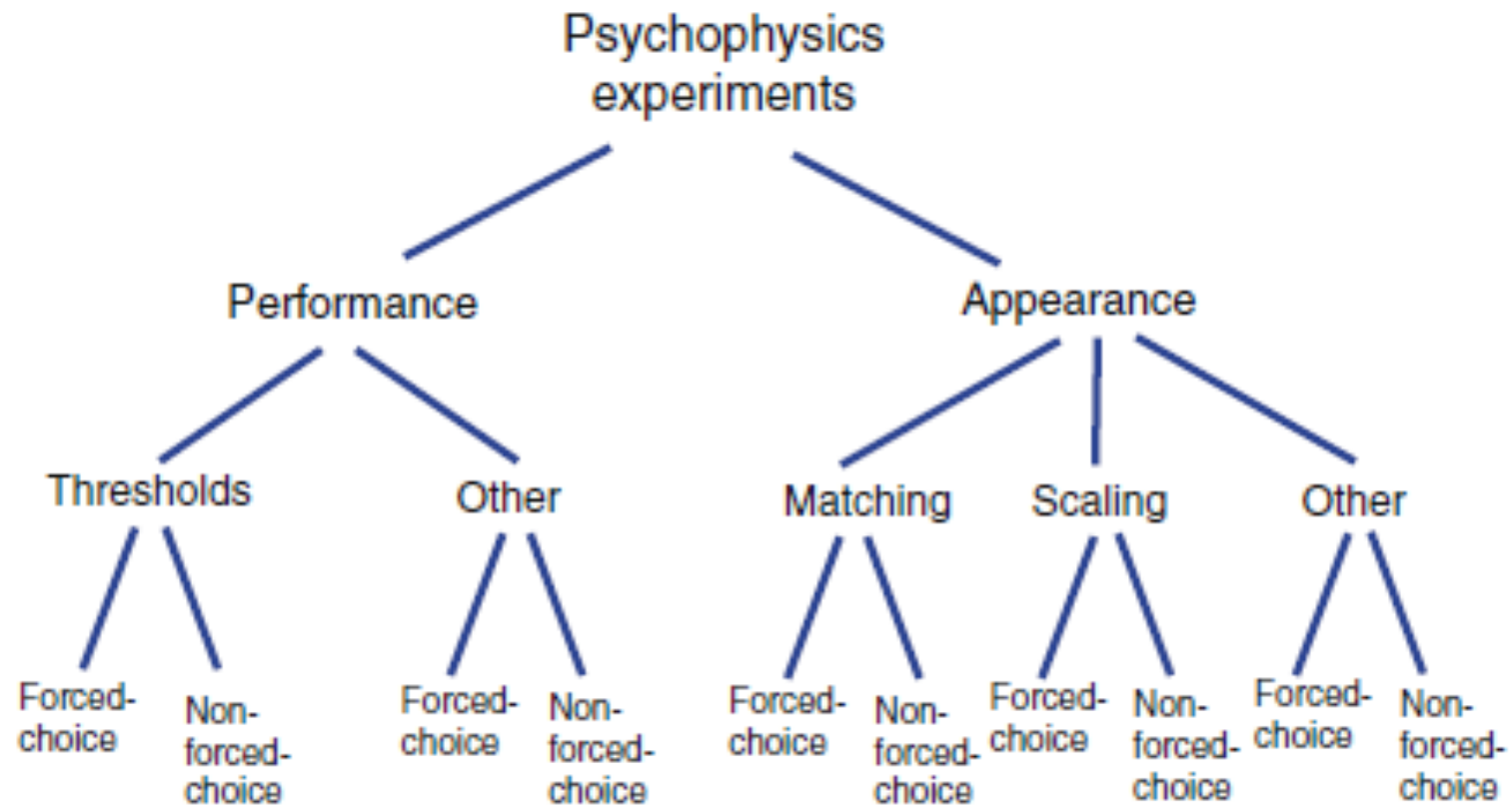


FIGURE 2.13 The initial stages of a scheme based on the performance-appearance distinction. An expanded version of the scheme is provided in the following chapter.

Methods overview

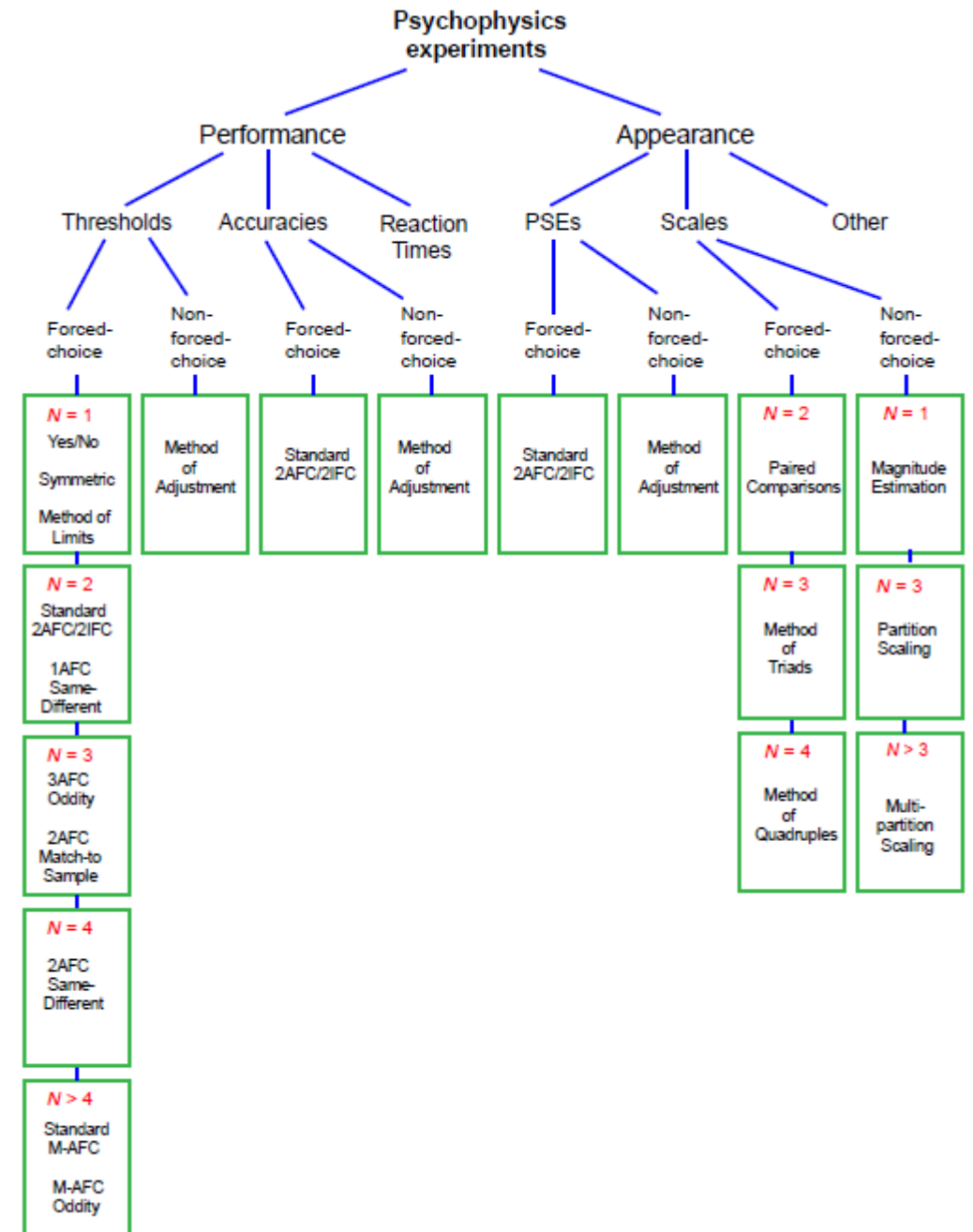


FIGURE 3.1 Expanded scheme for classifying psychophysical experiments.

Performance

Performance – Thresholds – FC N=1

- Method of limits*
- Yes/No
 - Usually 50:50
 - Bias problem, criterion dependent, d'
- Symmetric choices (1AFC)
 - Bias free
- Advantages
 - Time efficient
 - Low thinking/decision effort





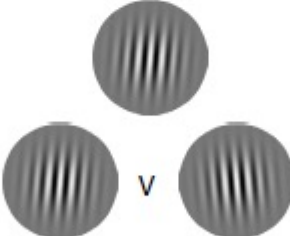
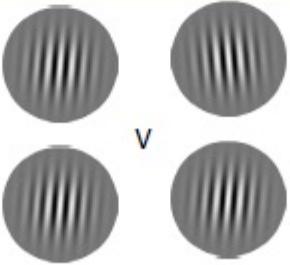
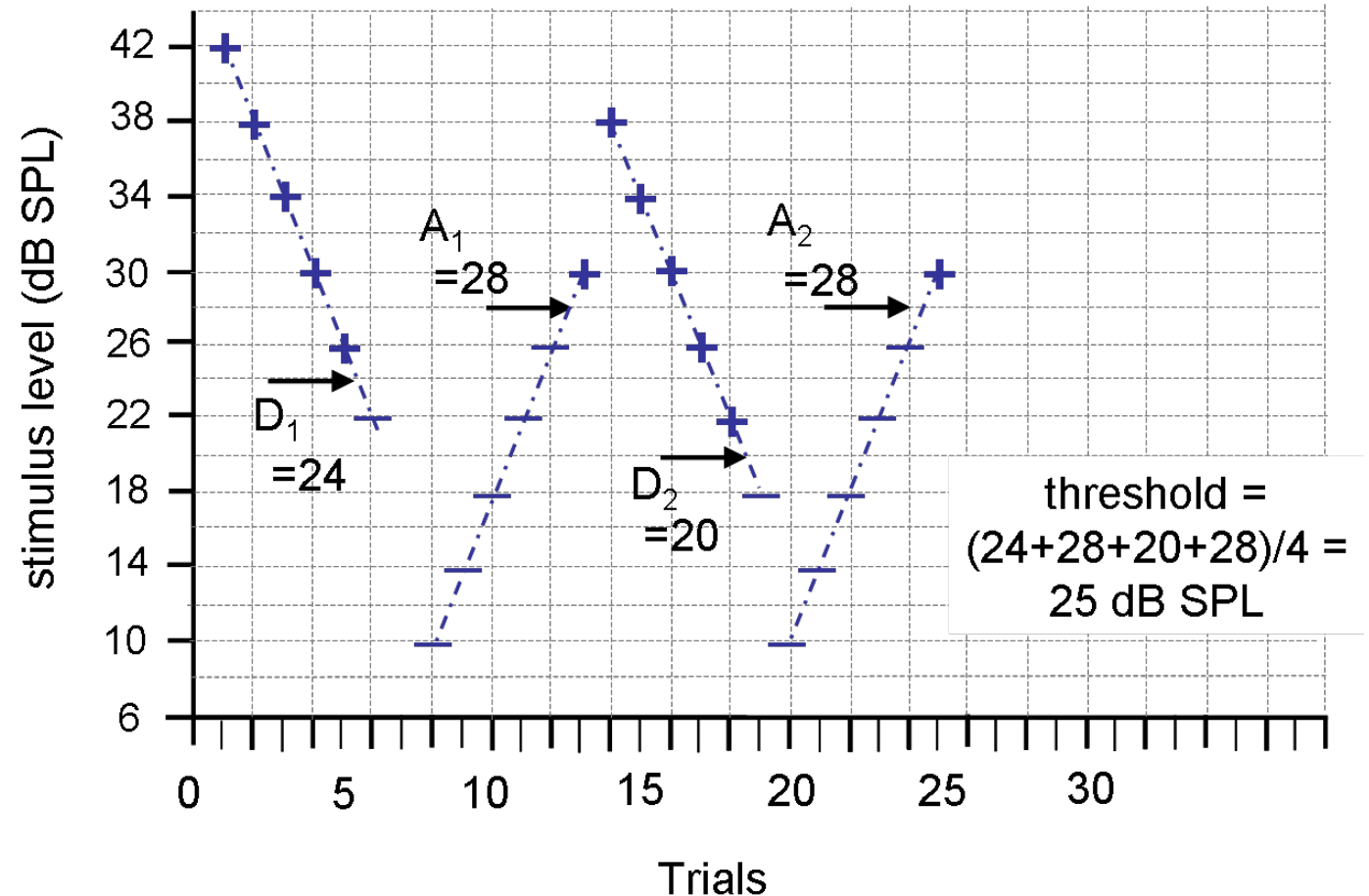
N	Task name	Stimuli per trial	Task
1	1AFC Symmetric		"Left-oblique or right-oblique?"
2	2AFC Standard		"Which one left-oblique?"
2	1AFC Same- Different		"Same or different?"
3	3AFC Oddity		"Which one the oddity?"
3	2AFC Match-to- Sample		"Which of the bottom pair is the same (or different from) the top one?"
4	2AFC Same- Different		"Which pair, top or bottom, is different (or same)?"

FIGURE 3.2 Different methods for measuring an orientation discrimination threshold. N = number of stimuli presented on each trial. Note that the number that prefixes the acronym AFC (alternative-forced-choice) is M , the number of stimulus alternatives presented per trial.

Method of limits

- Threshold measurements
- Not precise, estimation
- Verbal rapport
- Habituation/expectation
- Type 2 (we can't evaluate as correct)



Performance – Thresholds – FC N=2

- Standard 2AFC/2IFC
 - 2IFC – fovea possible, but twice as long
 - 2AFC – good for non-foveal stimuli, people cannot fixate (both)
 - We calculate % or d'
- 1AFC (same-different)
 - No explanations necessary (we don't know or complex)
 - Combinations S_1S_1 , S_2S_2 , S_1S_2 , S_2S_1
 - Bias problem (same vs different)
 - In animals (IFC)





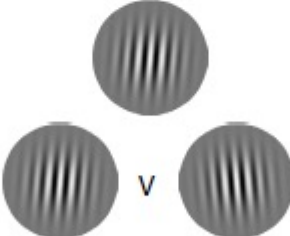
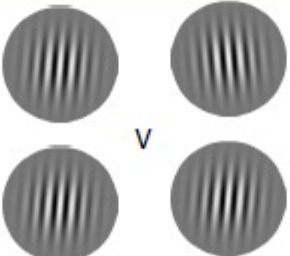
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Performance – Thresholds – FC N=3

- 3AFC oddity
 - Respondent does not need to understand the nature of difference
 - „triangular method“, popular
 - 3AFC nebo 3IFC
 - Sometimes difficult, memory load (IFC)
- 2AFC match-to-sample
 - Respondent does not need to understand the nature of difference
 - You can test memory effects (manipulate delay)
 - Easier than oddity





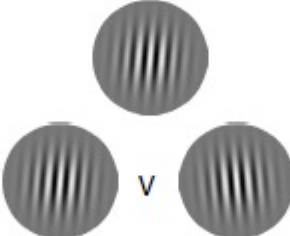
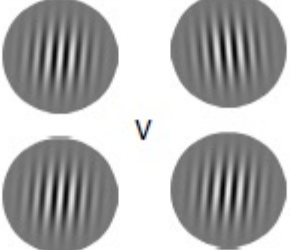
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FIGURE 3.2 Different methods for measuring an orientation discrimination threshold. N = number of stimuli presented on each trial. Note that the number that prefixes the acronym AFC (alternative-forced-choice) is M , the number of stimulus alternatives presented per trial.

Performance – Thresholds – FC $N=4$

- 2AFC/2IFC same-different
 - 2 pairs
 - Smaller bias problem vs 1AFC same-diff
 - Better than oddity (+1 stimulus, ale -1 alternativa)

- $N > 4$
 - M-AFC match-to-sample





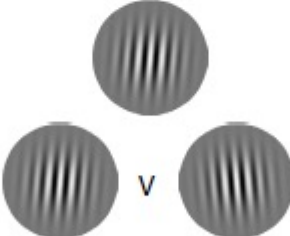
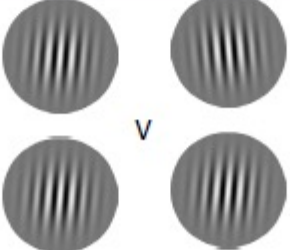
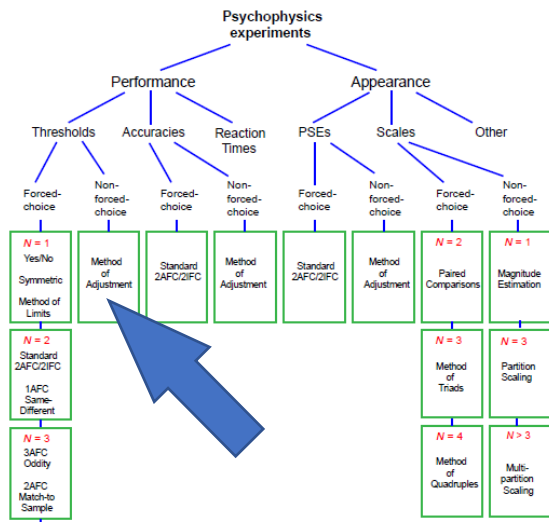
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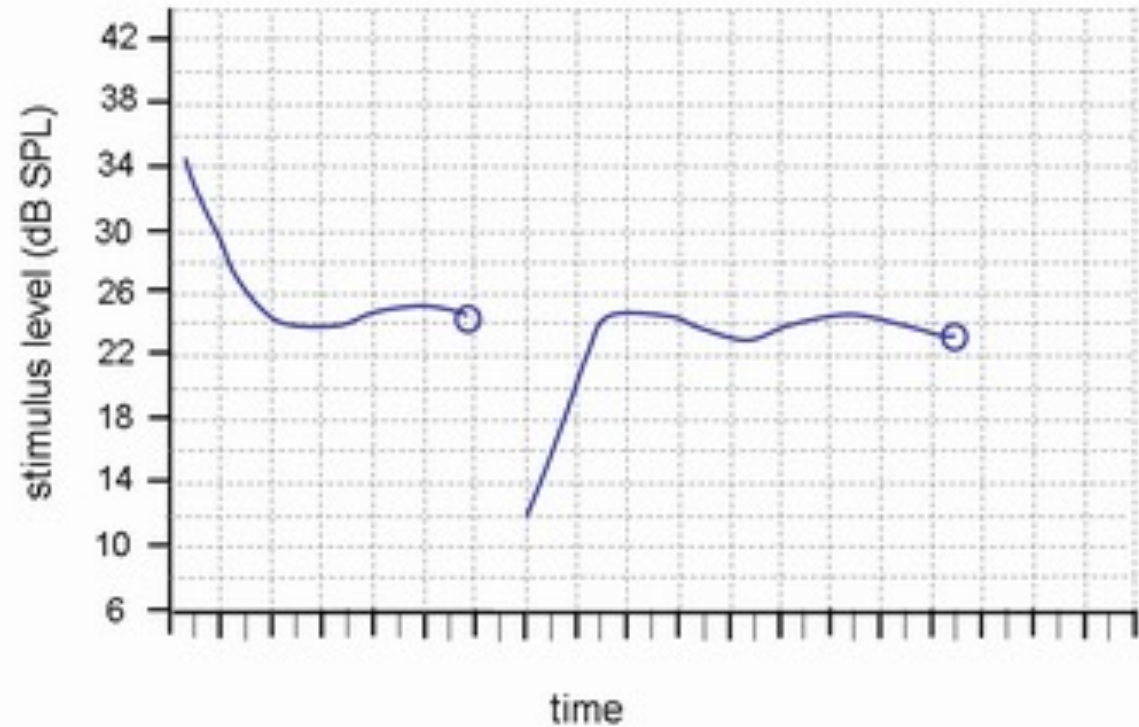
FIGURE 3.2 Different methods for measuring an orientation discrimination threshold. N = number of stimuli presented on each trial. Note that the number that prefixes the acronym AFC (alternative-forced-choice) is M , the number of stimulus alternatives presented per trial.

Performance – Thresholds – nonFC

- Method of adjustment
 - Not much used any more
 - For rough estimates



Method of Adjustment



Performance – Non-thresholds

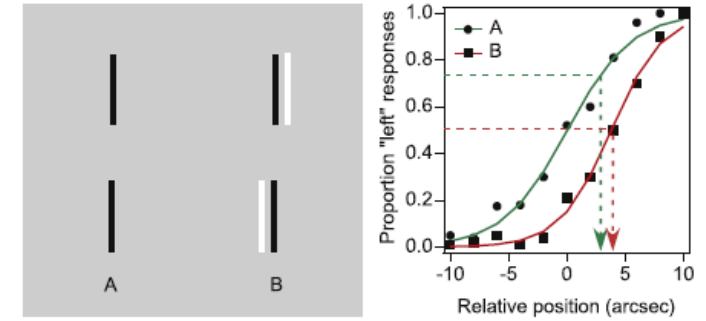


FIGURE 2.8 Left: stimulus arrangements A and B for two Vernier alignment experiments. Right: hypothetical data from each experiment. The abscissa plots the horizontal physical separation between the black lines, with positive values indicating that the top line is physically to the left of the bottom line and negative values indicating that the top line is physically to its right. The ordinate gives the proportion of times the observer responds that the top line is "left." The continuous curves are best-fitting logistic functions. The green arrow indicates for stimulus A the Vernier threshold and the red arrow indicates for stimulus B the point-of-subjective alignment.

■ Accuracy

- How far is the perceived value from the true value
- AFC, adjustment

■ Response time

- Usually combined with other methods (% accuracy)

Appearance

- Type 2, no „wrong“ answers
- Point of subjective equality (PSE) – matching
 - adjustment and FC possible

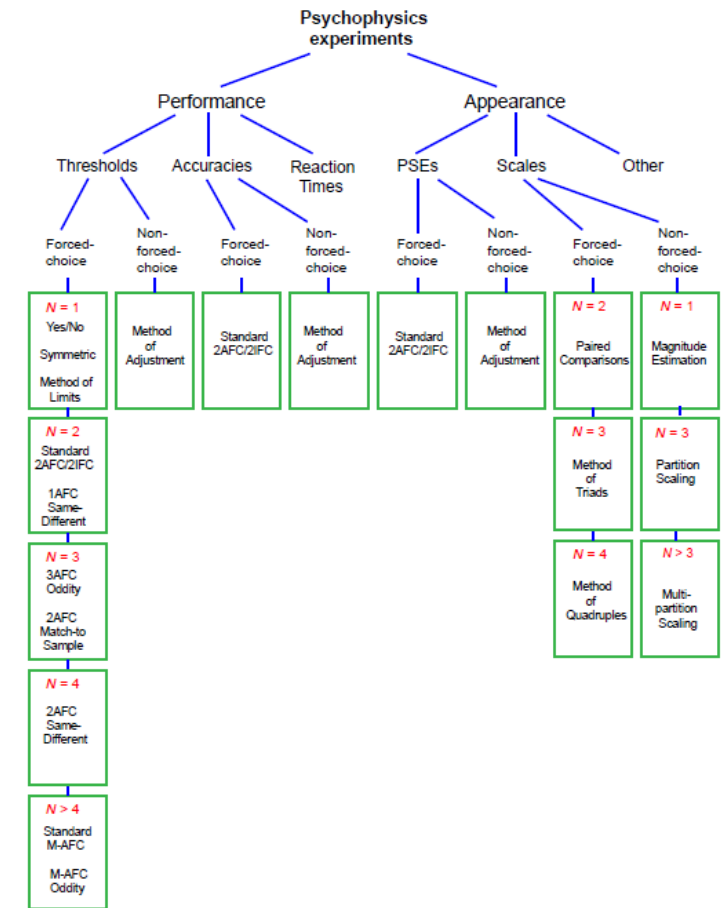


FIGURE 3.1 Expanded scheme for classifying psychophysical experiments.

Appearance – Matching - FC

- N=2 – matching with 2AFC/2IFC
 - Rayleigh match - What combination of wavelengths corresponds to the presented spectral range
 - ML illusion

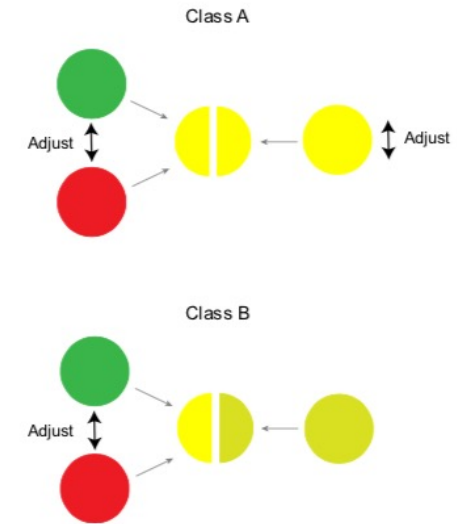


FIGURE 2.3 The Rayleigh match illustrates the difference between a Class A and Class B psychophysical observation. For Class A, the observer adjusts both the intensity of the yellow light in the right half of the bipartite field as well as the relative intensities of the red and green lights in the mixture in the left half of the bipartite field until the two halves appear identical. For Class B, the observer adjusts only the relative intensities of the red and green lights in the left half to match the hue of a yellow light in the right half that in this example is different in brightness.

Appearance – Matching - nonFC

- N=2 – matching by adjustment
 - 1 „test“ stimulus
 - 1 „adjustable“ stimulus
 - Must be repeated several times
 - We can evaluate precision (via SD)

- N=2 – nulling by adjustment
 - Task „eliminate“, „balance“
 - Př. Grating-induction illusion* (simul. brightness contrast)

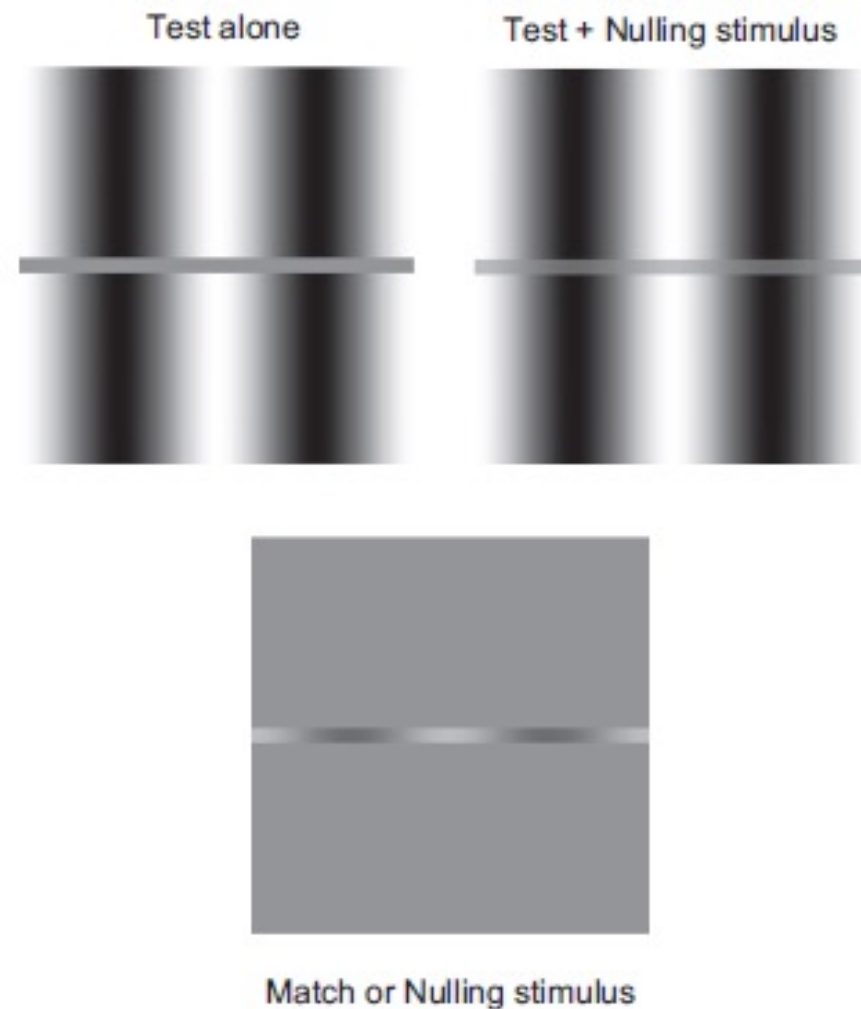


FIGURE 3.3 Matching versus nulling. Top left: grating induction stimulus. The horizontal gray stripe running through the middle of the luminance grating is uniform yet appears modulated in brightness due to simultaneous brightness contrast. Bottom middle: an adjustable grating with similar spatial dimensions to the induced grating can be used to match its apparent contrast. Top right: the same grating, however, can instead be used to null or cancel the induced grating when added to it. Note that the cancellation is not perfect, because of the limitations of reproduction. See text for further details.

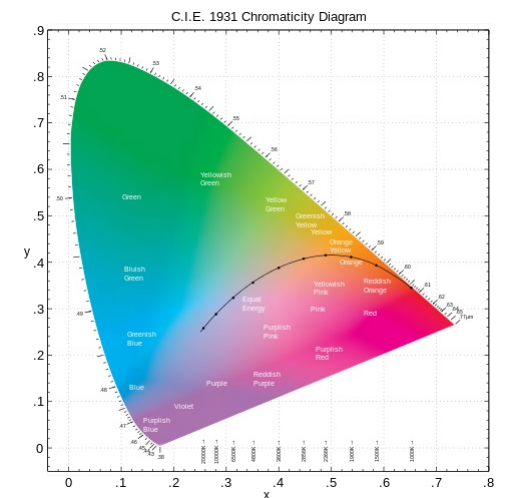
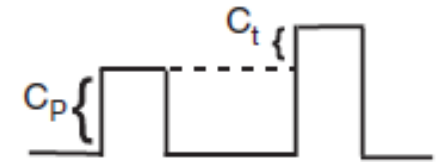
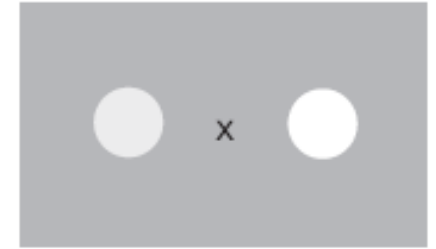
Appearance – Scaling

■ Types

- Ordinal – stimuli can be ordered
- Interval – meaningful differences, we can transform $y = aX + b$
- Ratio – magnitude („5x higher“), $y = Ax$

■ Sometimes more dimensions

- 1 – contrast
- 2 – colour (CIE)






Appearance – Scaling – FC

- N=2, pair comparisons
 - 10 faces, happier
 - Ordinal possible
 - Big similarity, proportion of correct responses – recalculations to interval scale

- N=3, method of triads
 - We do not need to say/know the dimension




Forced-choice

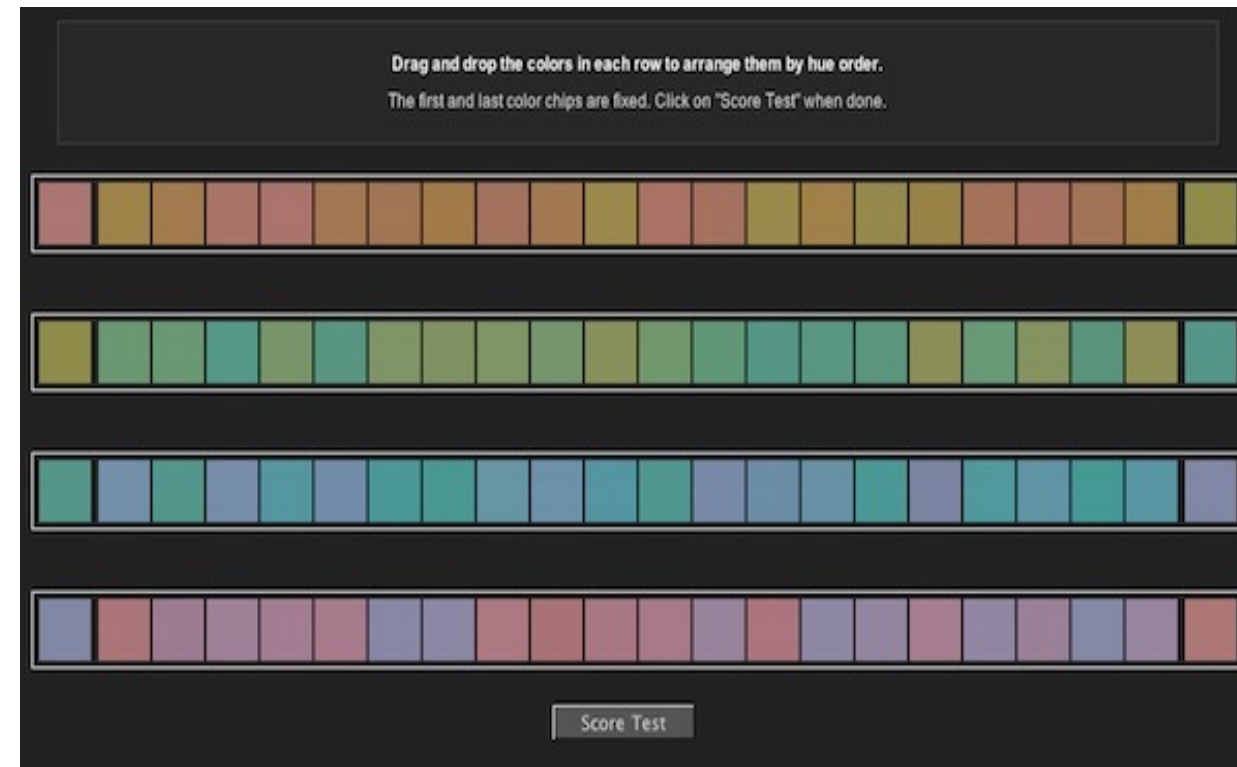
<i>N</i>	Task name	Stimuli per trial	Task
2	Paired Comparisons		"Which patch is brighter?"
3	Method of Triads		"Which of the bottom pair of patches is most similar (or different) to the top patch?"
4	Method of Quadruples		"Which pair of patches, top or bottom, are more similar (or different)?"

Appearance – Scaling – FC

- N=4, method of quadruples
 - 2 pairs
- N>4, multi-stimulus scaling
 - Arrangements in line
 - E.g. Farnworth-Munsell 100 hue test for color deficiency
- Multidimensional scaling
 - MDS, data using N=3, N=4

Forced-choice

N	Task name	Stimuli per trial	Task
2	Paired Comparisons		"Which patch is brighter?"
3	Method of Triads		"Which of the bottom pair of patches is most similar (or different) to the top patch?"
4	Method of Quadruples		"Which pair of patches, top or bottom, are more similar (or different)?"



Appearance – Scaling – nonFC

- N=1, magnitude estimation
 - Direct estimation
 - Presenting „anchor“, obtaining estimates
 - Nedoporučuje se (mnoho vlivů)
- N=3, partition scaling
 - „bisection“, „equisection“
- N>3, multipartition scaling
 - Start/end presented, split into regular intervals

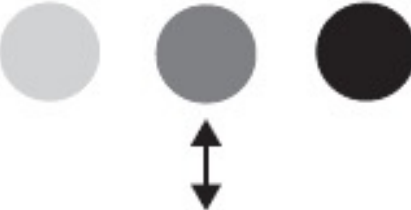
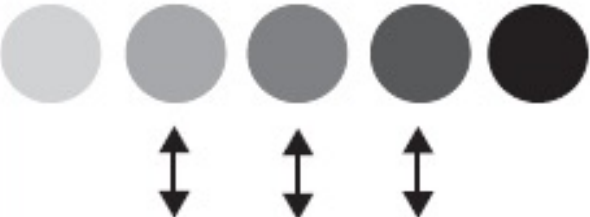
<i>N</i>	Task name	Stimuli per trial	Task
3	Partition Scaling		"Adjust the brightness of the middle patch until it appears mid-way between the anchors either side"
>3	Multi-partition Scaling		"Adjust the brightnesses of the patches between the anchors until all patches are at equal perceptual intervals"

FIGURE 3.4 Types of scaling task for deriving interval scales, applied to the example of brightness scaling. In nonforced-choice methods in the lower panel the double arrows refer to disks whose luminances are freely adjusted by the observer.

Other designs - methods

- *Method of adjustment*
- *Method of limits*
- Method of constant stimuli
- Adaptive procedures

Method of constant stimuli (constants)

- We need to start with plausible range of values near threshold
 - Not only guessing (50%) or too easy (100%)
- We pick several stimulus values
- We fit psychometric curve
- Many measurements required

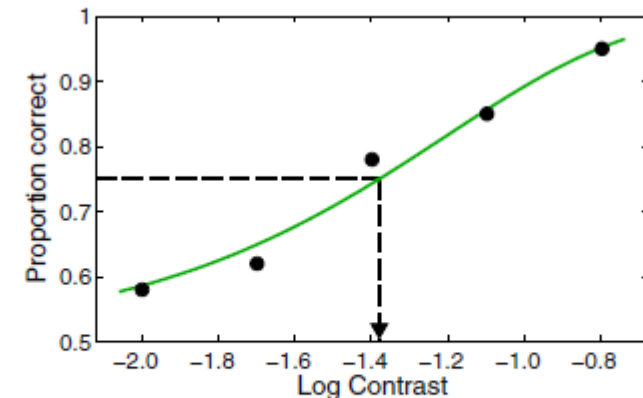
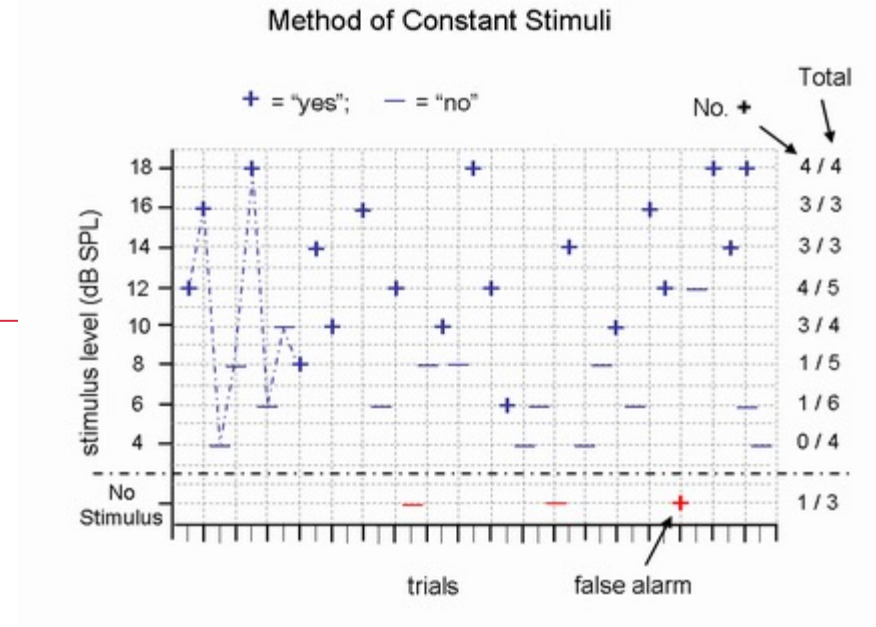


FIGURE 4.1 Example of a PF from a hypothetical experiment aimed at measuring a contrast detection threshold. The threshold is defined here as the stimulus contrast at which performance reaches a proportion correct equal to 0.75. Data are fitted using a log-Quick function.

Adaptive procedures

- E.g. „staircase“
- More time-efficient
- Stimulus values selected based on previous responses
- Used for threshold estimation
- Possible to combine with other methods
 - Psychometric curve (slope/threshold)
 - Performance-based or Appearance-based

Terminology - timing

“There is no hard and fast rule here, and the experimenter is encouraged to try out different ISIs until the task feels comfortable. As a rule of thumb, a stimulus exposure duration of 250 ms, an ISI of 500 ms, and an intertrial- interval (ITI) of 1000 ms is a good starting point.”

- „self-paced“
- ITI, ISI
- Stimulus onset asynchrony

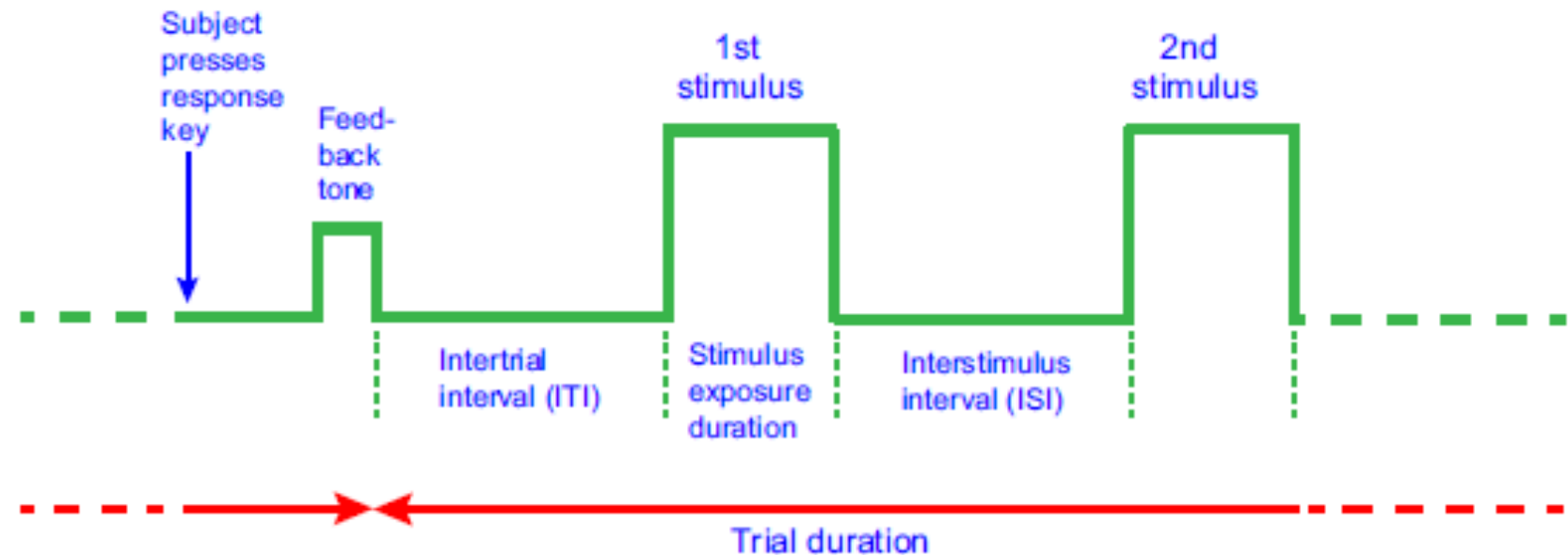


FIGURE 3.5 Example timing of stimulus presentation during a typical 2IFC trial.