Cognitive (Neuro) Psychology

VI. Scaling Methods

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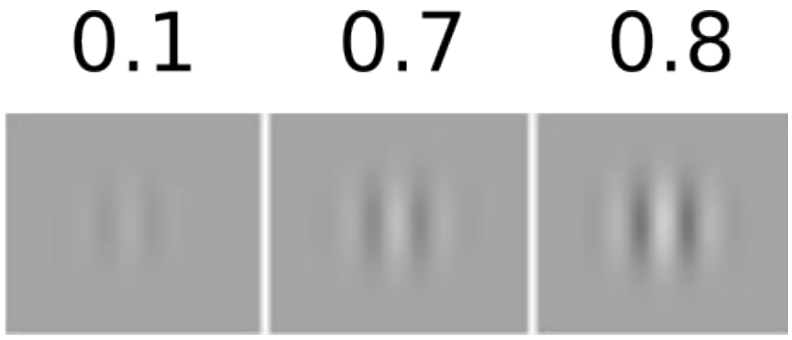
So far ...

Perceptual Scales

- psychological scales
- sensory scales
- transducer functions

describe the relationship between the perceived and physical magnitudes of a stimulus, e.g. transparency and perceived transparency

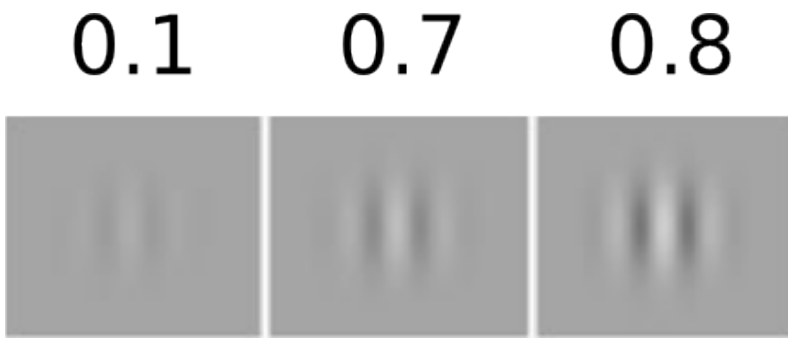
Types of perceptual scales



ordinal:

- number stimulus magnitudes according to their rank order along perceptual continuum, difference between any pair of number does not necessarily correspond to magnitude of the perceptual difference, e.g. 1, 2, 3
- differences between numbers do not correspond to perceived differences

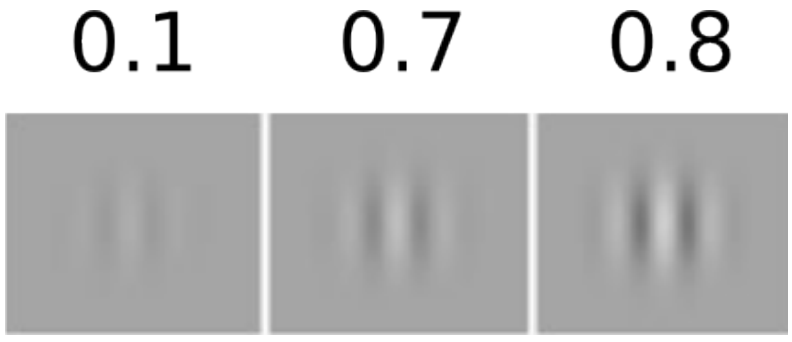
Types of perceptual scales



interval:

- interval: differences between number correspond to perceptual differences, even though numbers themselves are arbitrary, e.g. 1, 5, 6 or 4, 12, 14, an interval scale can be transformed without loss of information by the equation $aX + b$
- does not capture perceived relative magnitudes of the stimulus dimension

Types of perceptual scales



ratio:

- interval: capture relative perceived magnitudes, e.g. values of 1 and 5 indicate that the second value is five times the first

Forced-choice vs. non-forced choice scaling procedures

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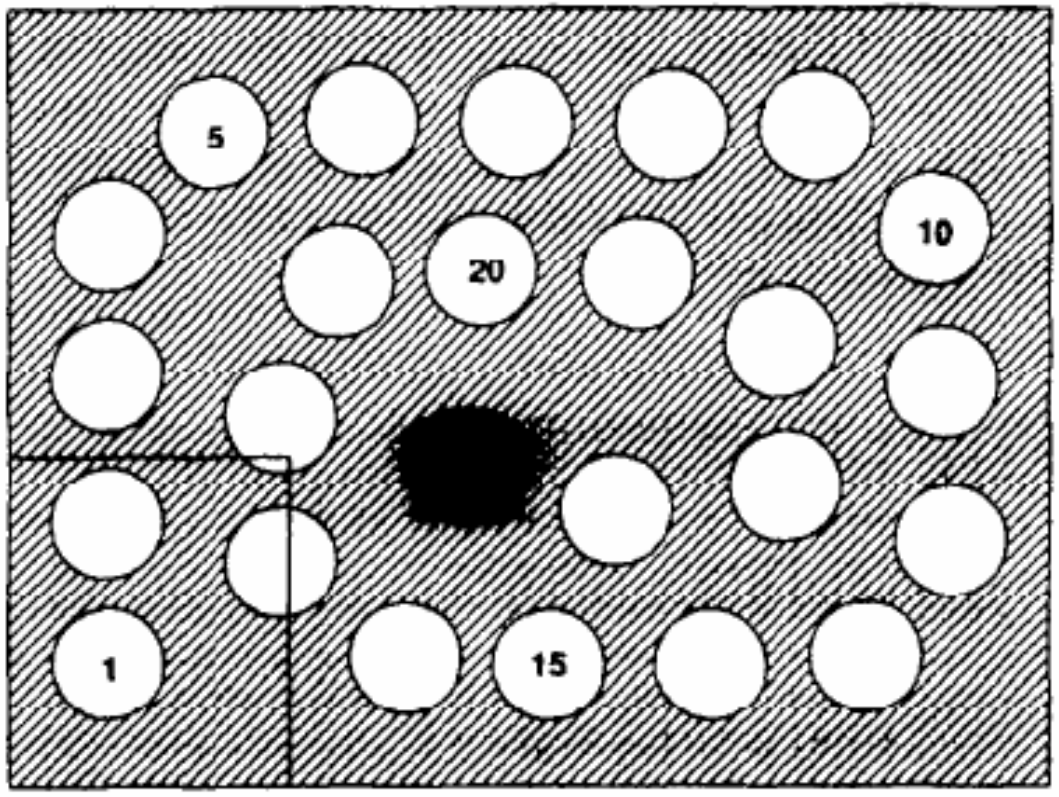
Example: Multi-partition scaling



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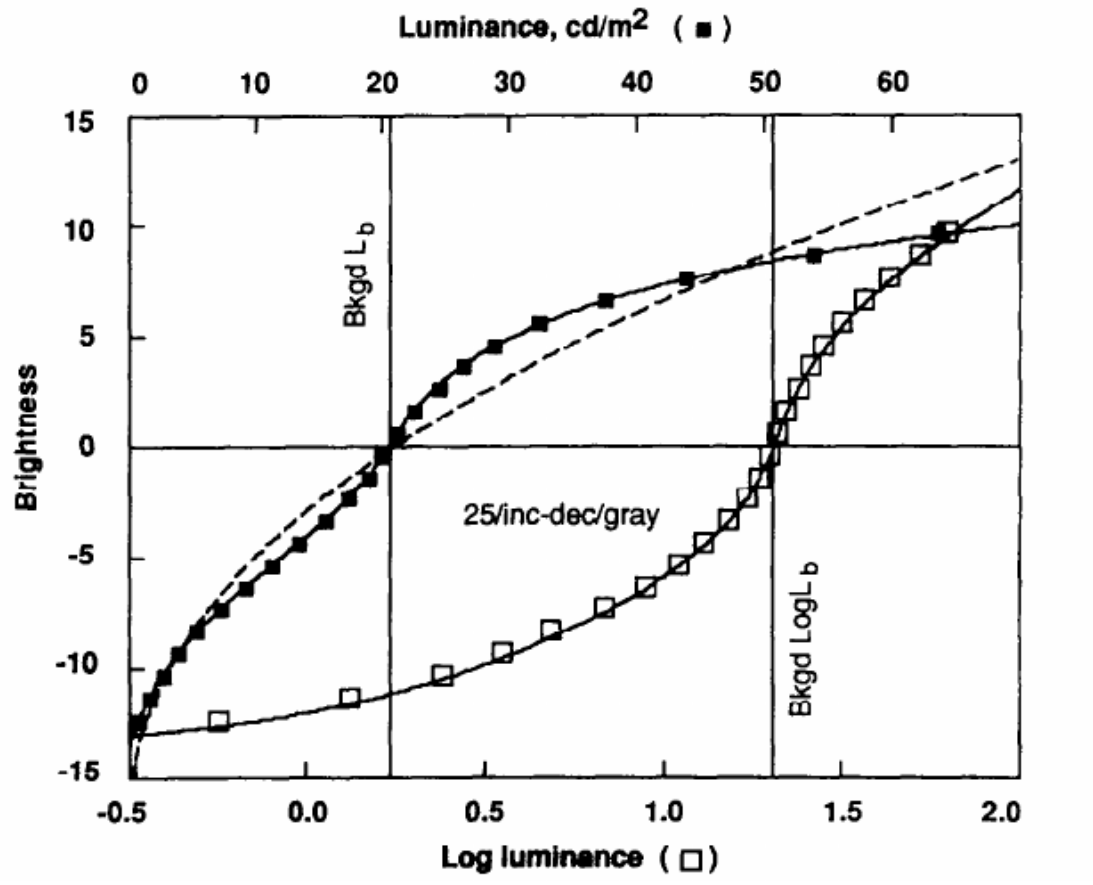
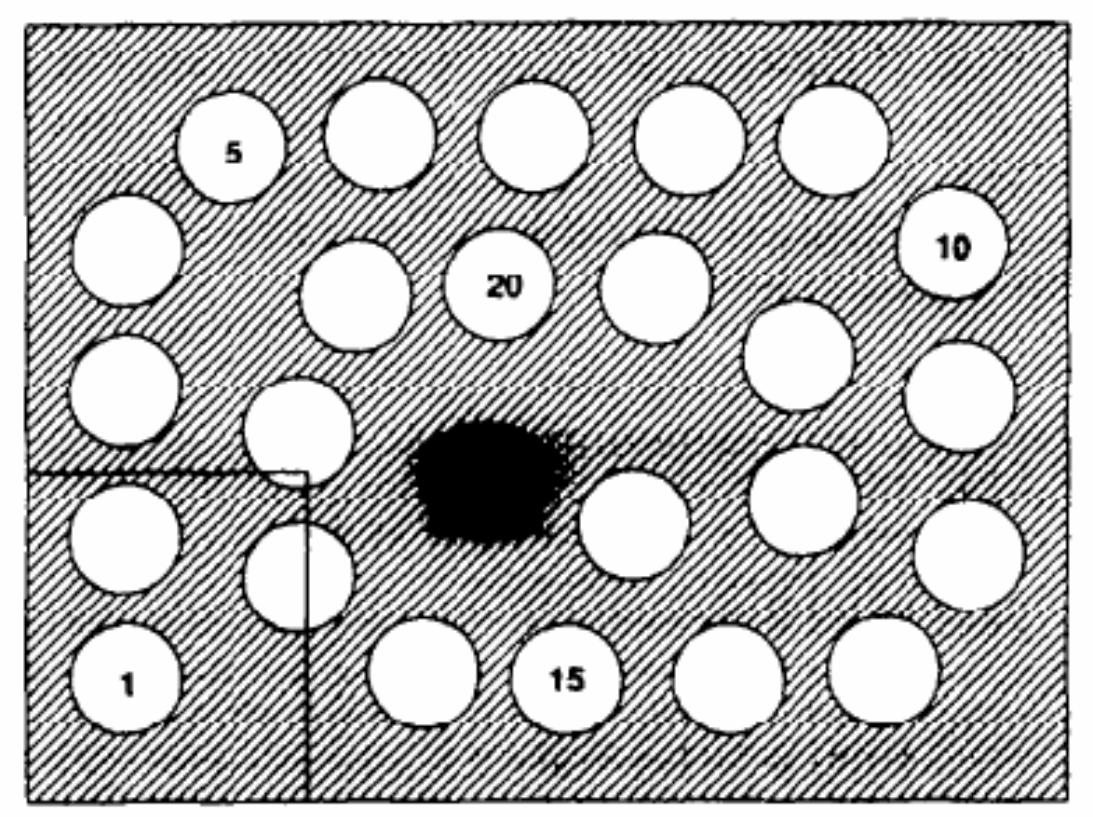


General principle of a perceptual scale

- perceptual scale is power function $\Psi(x) = a * S^n$
- quadruples
- equal physical magnitudes, different perceptual magnitudes and vice versa



Maximum Likelihood Difference Scaling - MLDS

Maloney & Yang, 2003

- forced-choice scaling procedure
- state-of-the-art optimization
- produces interval perceptual scale

How MLDS works

- set of stimulus magnitudes $S_1, S_2, S_3, ..., S_n$
- $\Psi(2), \Psi(3), \Psi(4), ..., \Psi(n-1)$ are free parameters that have to be estimated, $\Psi(1)$ and $\Psi(n)$ are fixed at 0 and 1

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- observer: S_1, S_2 is more different
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- likelihoods of all trials are multiplied to obtain across-trials likelihood

Single trial example

- initial guesses for parameters:
  $\Psi(1) = 0.5$, $\Psi(2) = 0.7$, $\Psi(3) = 0.2$, $\Psi(4) = 0.3$
- internal decision noise is: $\sigma_d = 0.1$

$\Rightarrow$ $L(S_1, S_2)|(\Psi(1), \Psi(2), \Psi(3), \Psi(4))$

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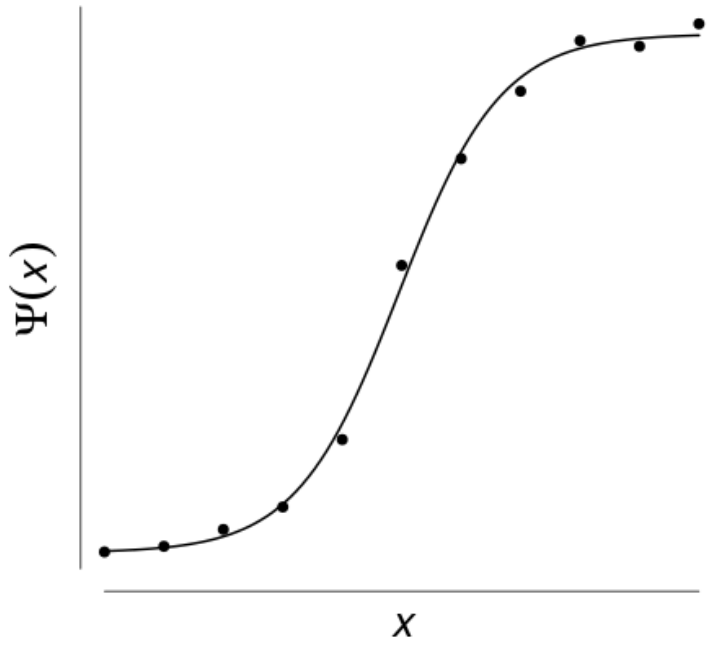
- convert to z-score $\frac{D}{\sigma_d} = 1$
- calculate area under the standard normal distribution
  $\Phi(z = 1) = 0.8413$

Relationship between z-scores and probabilities



- subdiscipline of psychology
- addresses the relationship between physical stimuli, x, and their subjective correlates (percepts), $\Psi(x)$

Summary

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References

- Kingdom & Prins, Psychophysics. A practical introduction.
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