Searching with or without probability: The description-experience gap in visual search performance

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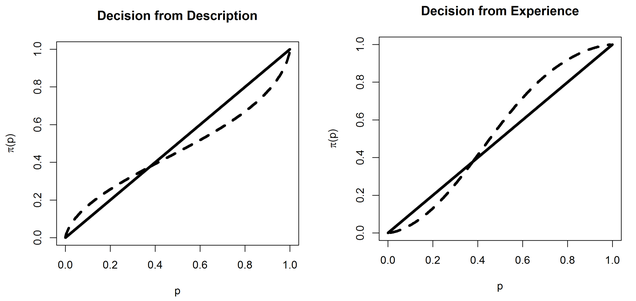
Mathematical Modeling of Human Performance

Introduction

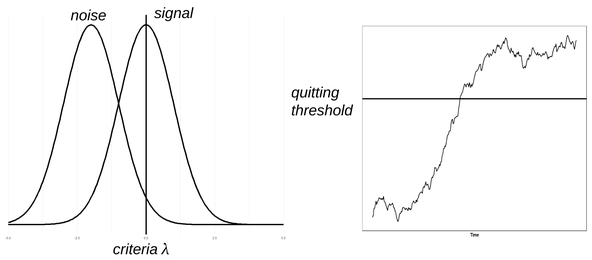
- A common feature in our daily search is that the targets are in low probability (e.g. airport security screening, breast cancer detection).
- *Prevalence effect:* Targets are usually missed in the low target probability condition.
- Most prevalence visual search studies do not make assumptions about how observers accumulate probabilities.
- *The description-experience gap:* Decisions with choice from experience are different compared to decisions made with the given event probabilities.



overweight small probabilities *underweight* moderate and high probabilities (prospect theory, Kahneman & Tversky, 1979)

underweight small probabilities *overweight* moderate and high probabilities (Hertwig et al., 2004)

- Current study compares the visual search from experience and visual search from description by fitting the dual-threshold model (Wolfe & Van Wert, 2010).



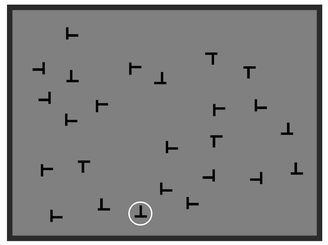
overweight target probability: liberal criteria to report more hits and false alarms; longer search time before quitting the trial.

underweight target probability: conservative criteria to report less hits and false alarms; shorter search time before quitting the trial.

Experiment

- Subjects: *N* = 20 (Age 18~31)
- Conditions
  - 4 Prevalence (0.1, 0.35, 0.65, 0.9)
  - 2 Information (experience, description)
  - 2 Rewards schemes (neutral, penalty)
  - 2 Salience Manipulations (high, low)

Rewards Schemes Adapted from Navalpakkam et al., (2009)				
	Correct Rejection	False Alarm	Miss	Hit
Neutral	+1	-50	-50	+1
Penalty	+1	-50	-900	+100



In the high salience trials, the high discriminability stimuli were as twice likely to show up as the low salience discriminability stimuli (vise versa in the low salience trials).

Results

Signal Detection Analysis

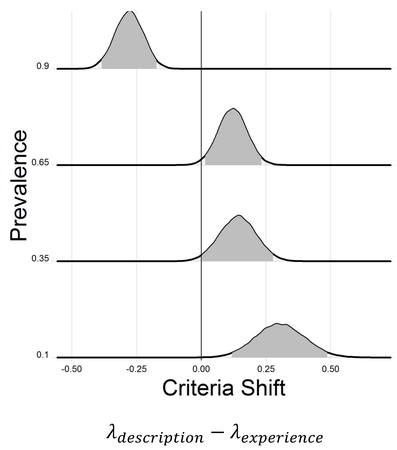
$$\log \beta_{optimal} = \log\left(\frac{cf}{hm}\right) - logit\ (s)$$

s: target probability

$$hm = v(hit) - v(miss)$$

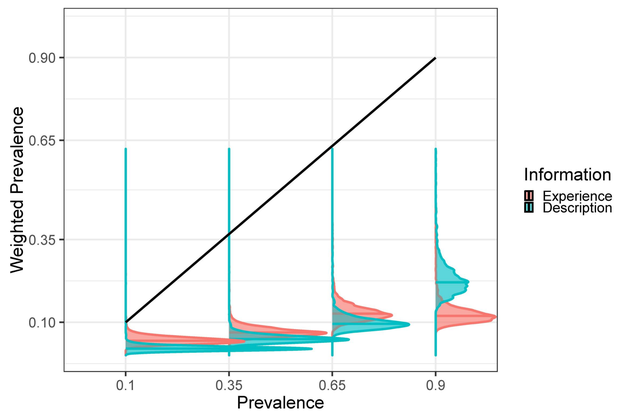
$$cf = v(correct\ rejection) - v(false\ alarms)$$

$$\lambda_{optimal} = \frac{\log(\beta_{optimal})}{d'} + \frac{d'}{2}$$



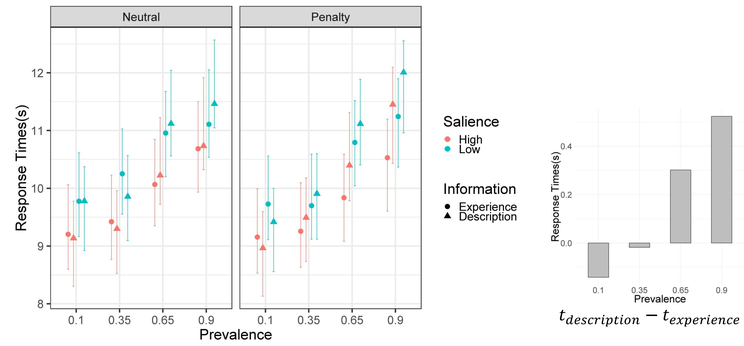
$\lambda_{description} - \lambda_{experience}$

shaded areas represented 95% high density intervals (Meredith & Kruschke, 2018)



Implied probability weighting assuming optimal performance (neutral reward condition)

Quitting Threshold



error bars represented 95% density intervals from the predicted posterior distribution of the Bayesian model including all factors

- Bayesian ANOVA
  - 1st RT ~ Information + Reward + Prevalence + Salience + Information x Salience
  - 2nd RT ~ Reward + Prevalence + Salience (Bayes Factor = 1/2.87)

Discussion

- Different from predictions of description-experience gap in the decision making research, our results suggested that:
  - In the low prevalence conditions, observers had more liberal criteria and searched longer without the target probability instruction (i.e. *search from experience*).
  - In the high prevalence conditions, observers had more liberal criteria and searched longer with the known target probability information (i.e. *search from description*).
- Consistent with the previous study, high penalty on missed errors persuaded observers to report more target present. However, observed criteria were still conservative compared to the optimal criteria, indicating that observers were biased to say “no” in target searching.
- In the future study, we would like to compare different models such as Linear Ballistic Accumulator in fitting response times and explore the utilization of the *gap* in “curing” the prevalence effect.

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