Speed-Accuracy Tradeoff

Outline

- Motivation
- Speed-Accuracy Tradeoff Function (SATF)
- A Study of the Effect of Alcohol

Motivation

- So far, we discussed measuring performance in terms of accuracy (AL, DL, d′, percent-correct).
- Another useful measure of human performance is response time.

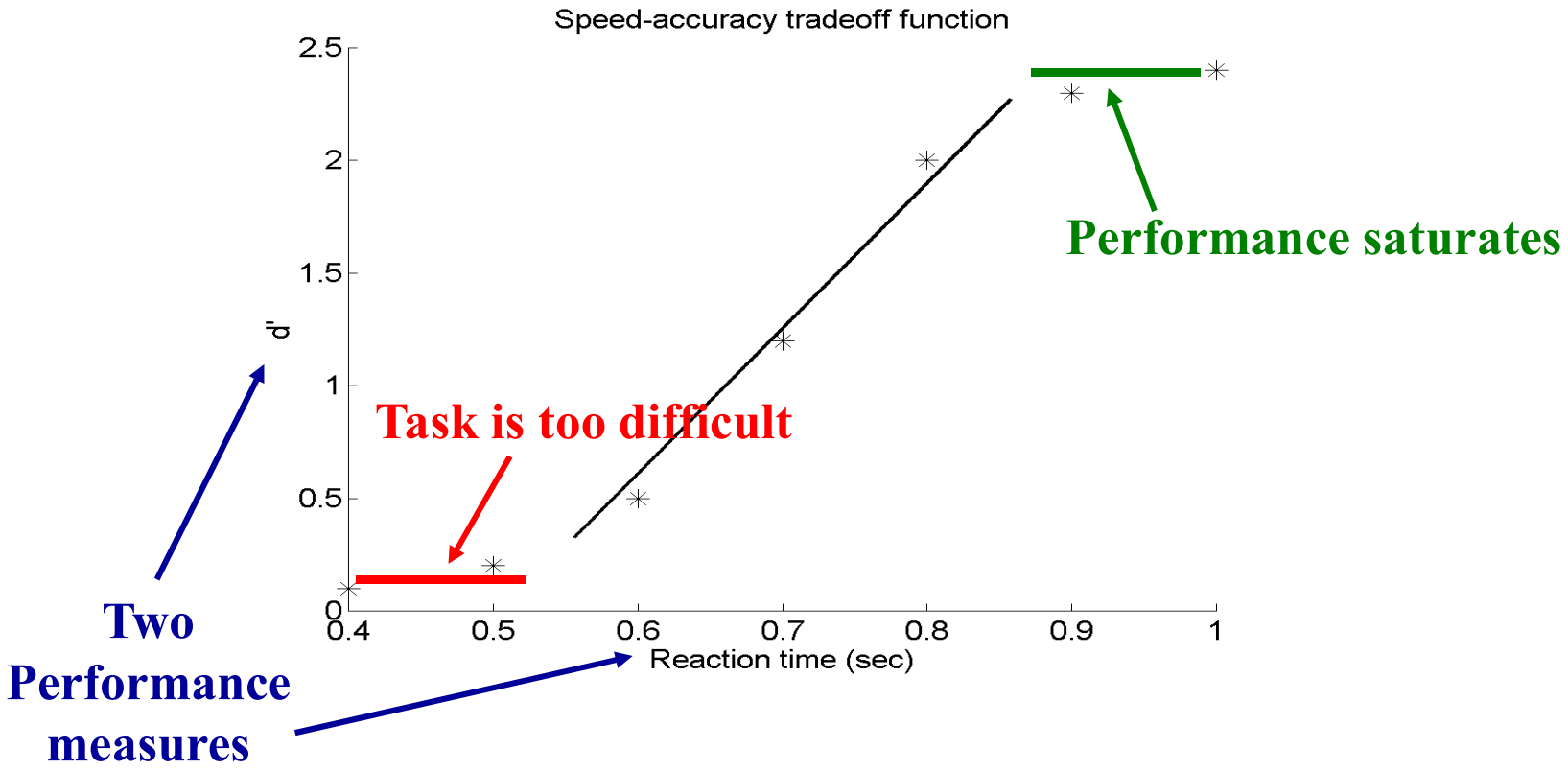
Motivation

- Human observers can trade the speed for accuracy. It follows that the effect of experimental condition on accuracy of the response can be confounded with the subject's criterion for the speed of the response.
- Similarly, if accuracy is not measured, response time (or reaction time, RT) confounds the speed of perceptual processing with the subject's criterion for the accuracy of the response.

Speed-Accuracy Tradeoff Function

- In order to measure properties of the percept (speed, accuracy) unconfounded with the criterion for the speed of the response, one should measure the entire speed-accuracy tradeoff function.
- This logic is similar to using the ROC curve in SDT in order to separate accuracy of the percept from the response bias.

- **Consider a hypothetical experiment in which both d′ and RT were measured. The plot of d′ against RT is the speed-accuracy tradeoff function (SATF):**



How to Measure SATF?

- Run your detection, discrimination or identification experiments as usual, except that
- Subjects are required to respond before a deadline (e.g., a beep, a flash of light)
- The deadline can be reinforced by instructions and/or payoffs
- Always check the data for actual reaction time

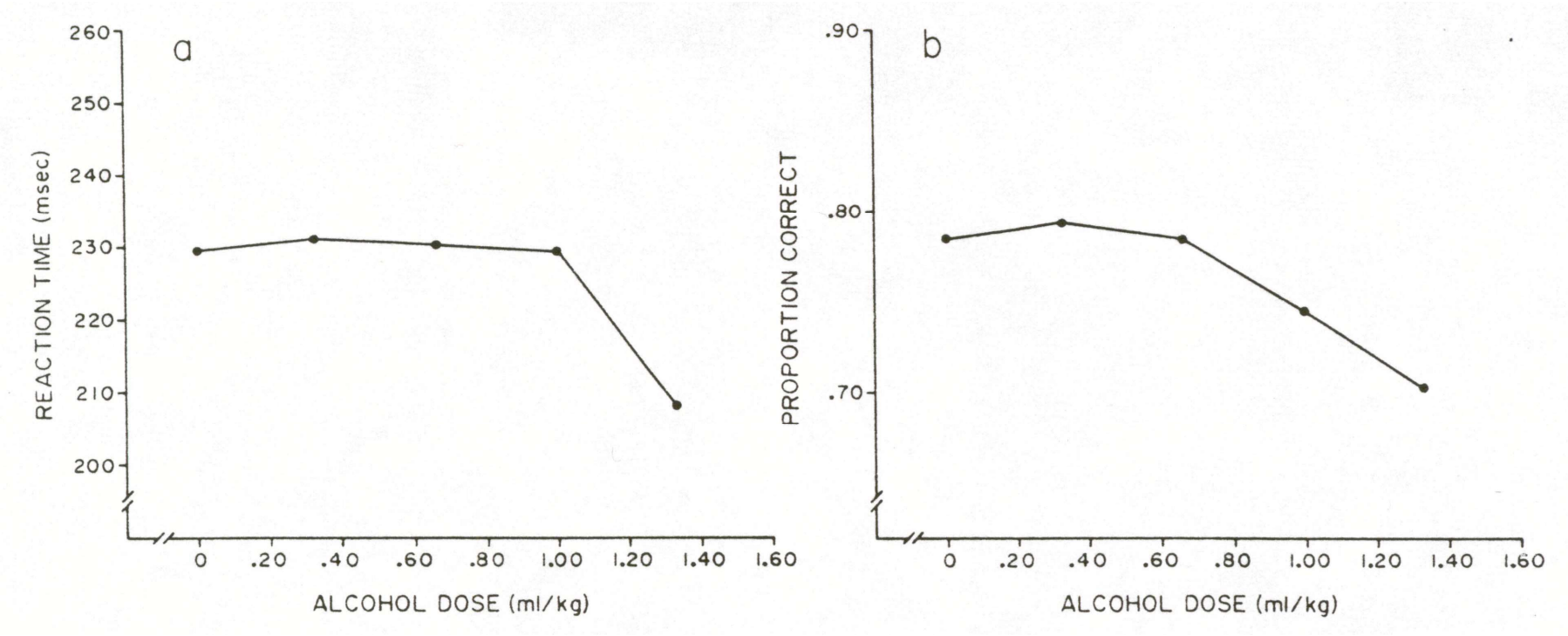
A Study by Jennings *et al.* (1976)

- **Motivation**
  - **Several past studies reported no significant effects of alcohol on reaction time (RT)**
  - **Jennings *et al.* decided to map out the entire speed-accuracy tradeoff function by inducing subjects to vary their speed-accuracy criteria systematically over a wide range, in order to obtain pairs of joint speed-accuracy values reflecting different criteria.**

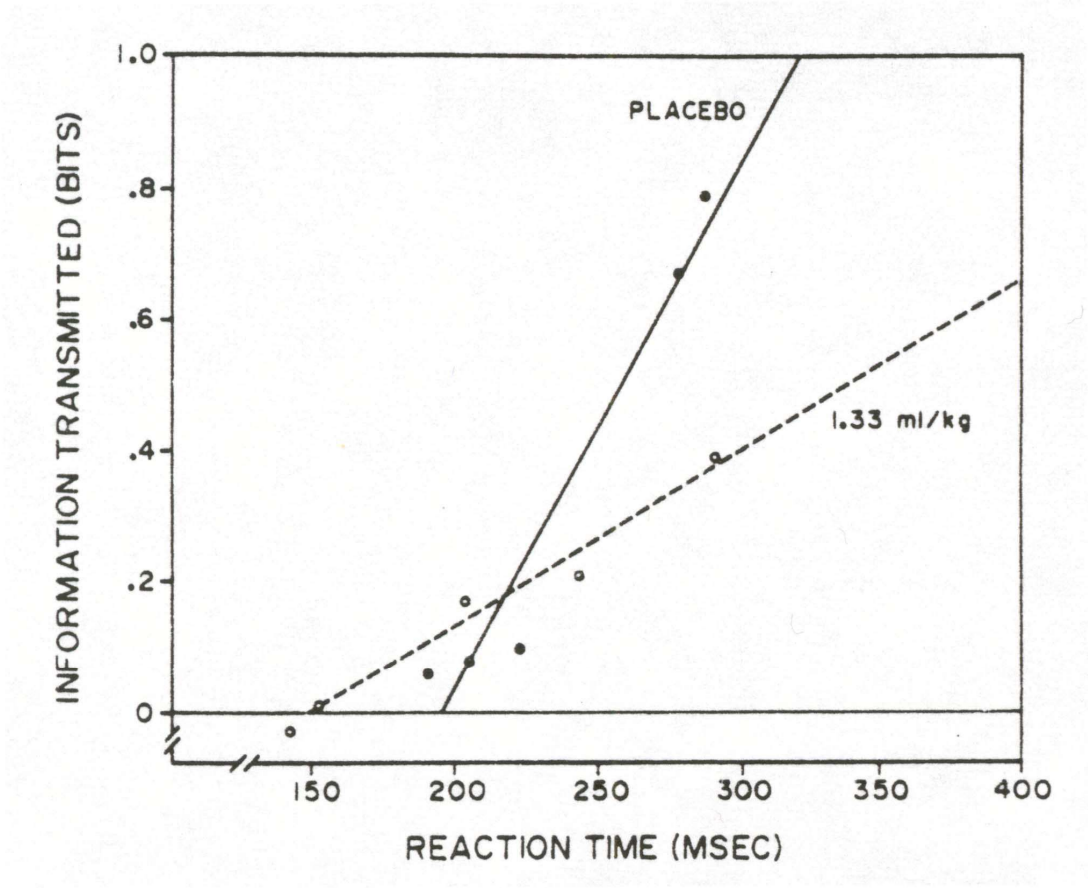
(*cont.*)

- **Task: identification of 1000 and 1100 Hz tones at 70 dB SL**
- **A visual deadline signal came on after one of the following intervals: 175, 225, 275, 325, and 375 ms**
- **Alcohol doses: placebo, 0.33, 0.67, 1.00 and 1.33 ml of 95% ethyl alcohol/kg body weight**
- **Trial-by-trial correct-answer feedback was provided**
- **Performance was measured in terms of IT in *bits***

Preliminary Data Analysis

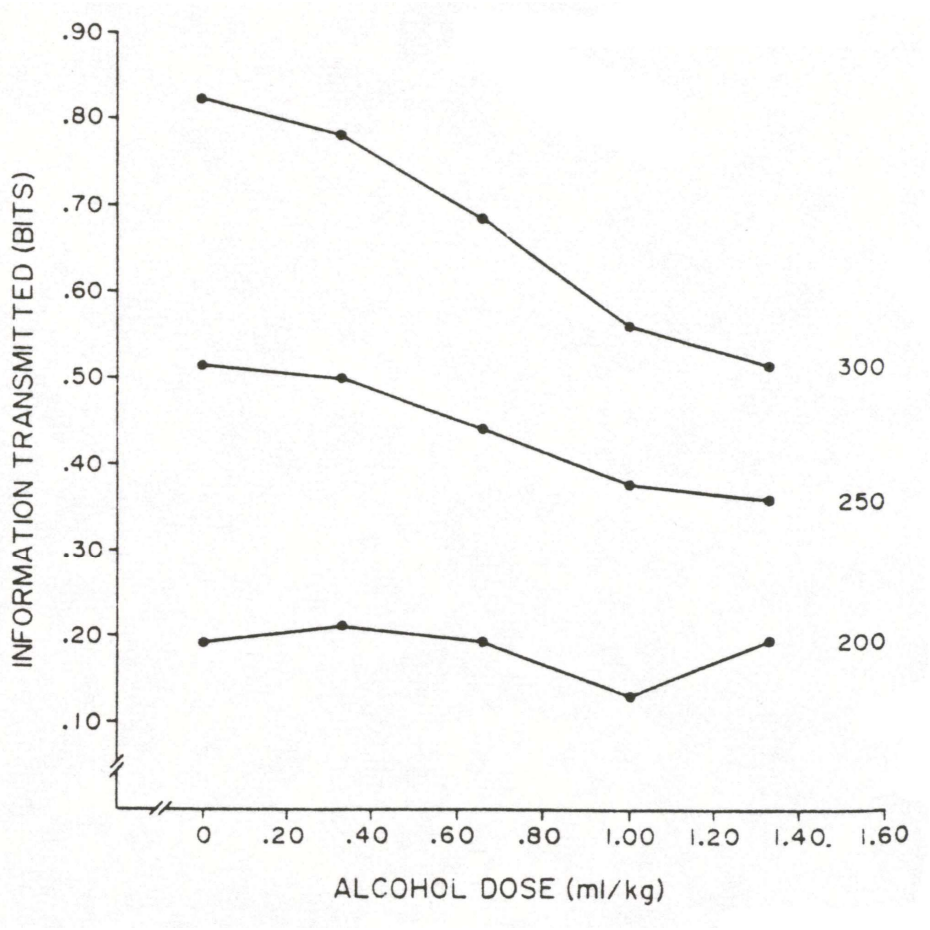


Alcohol and SATF



- Slope of fitted straight line is a measure of speed (compare with d′ in ROC curves)
- Intercept is hard to interpret (it is usually outside performance range)

Equal-RT Contours



Discussion

- The intermediate part of SATF can be approximated by a straight line. The slope of the line is a measure of the speed of perceptual processing.
- It is clear that higher performance level can be achieved by slowing down the responses.

Discussion (*cont.*)

- To properly conduct an experiment that measures accuracy alone
  - Allow sufficient time for subjects to respond (we assume that they optimize their speed criterion towards highest accuracy)
  - Note that, if too much time elapses between onset of stimuli and that of responses, accuracy may suffer as a result of "faded" memory

Discussion (*cont.*)

- To properly run an experiment that measures response time alone
  - Ask subjects to adjust their accuracy criterion towards pre-determined accuracy level
  - Always record accuracy data

Summary:
Three Types of Response Biases

- When classical psychophysical methods are used to measure AL, the estimated threshold is confounded with a subject's criterion about 'detectable'.
- The resulting bias is removed in Signal Detection Experiment. The experiment measures both the percept (d′) and the response bias.
- d′ may change, however, if the subjects changes the criterion for the speed of the response. To eliminate this bias, one should measure both the accuracy and speed (SATF).

Summary (*cont.*)

- **There is a third kind of response bias in a task where a subject is required to attend to two (or more) things simultaneously. A subject may choose to pay more/less attention to one thing than the other. To eliminate the effect of the subject's criterion as to where the attention should be allocated, one should measure AOC – Attention Operating Characteristics.**

References

- Jennings, J.R., Wood, C. & Lawrence, B.E. (1976) Effects of graded doses of alcohol on speed-accuracy tradeoff in choice reaction time. *Perception & Psychophysics* 19, 85-91.
- Luce, R.D. (1986) *Response Times*. New York: Oxford University Press.