

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**.

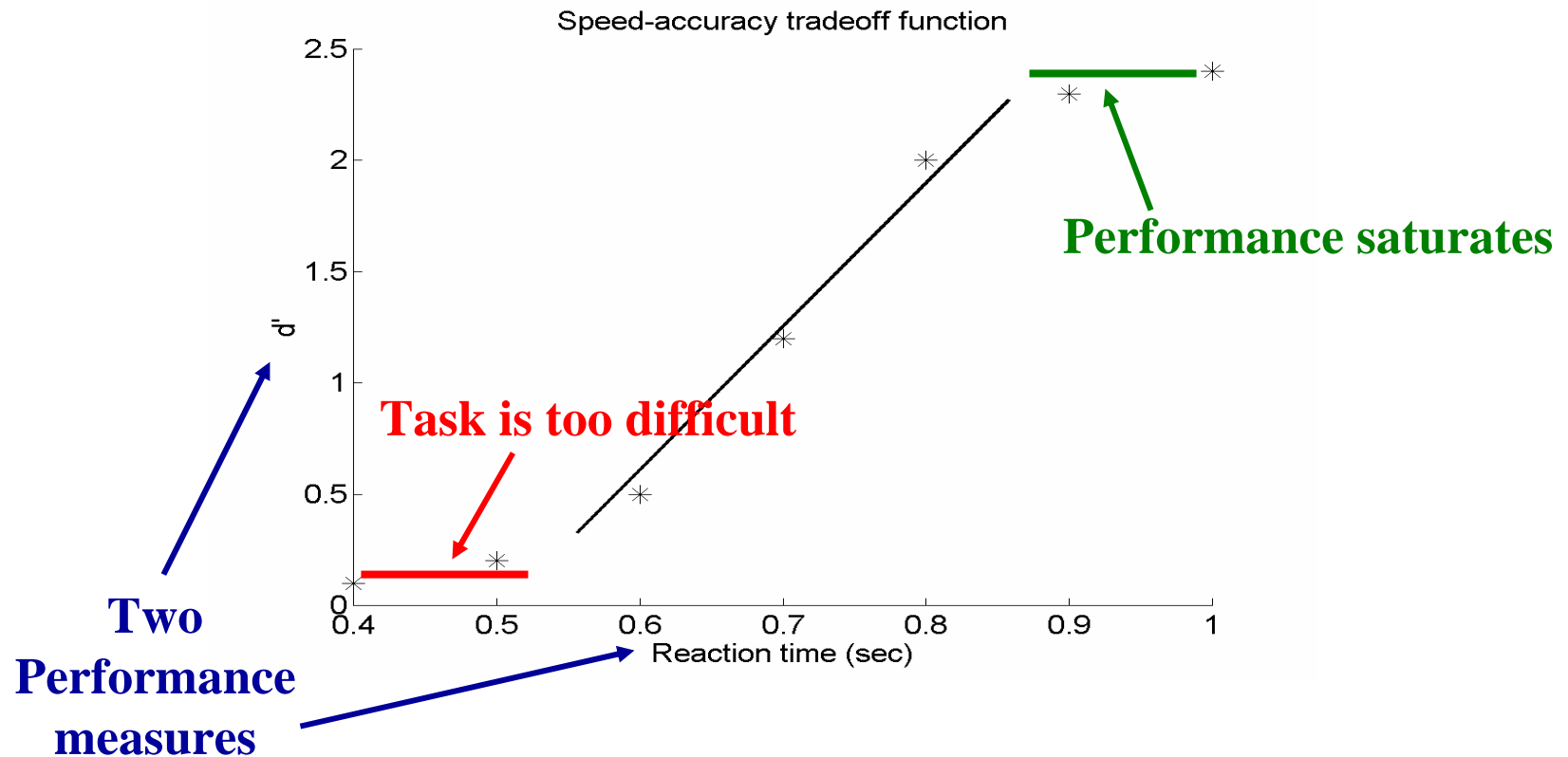
Motivation

- 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)

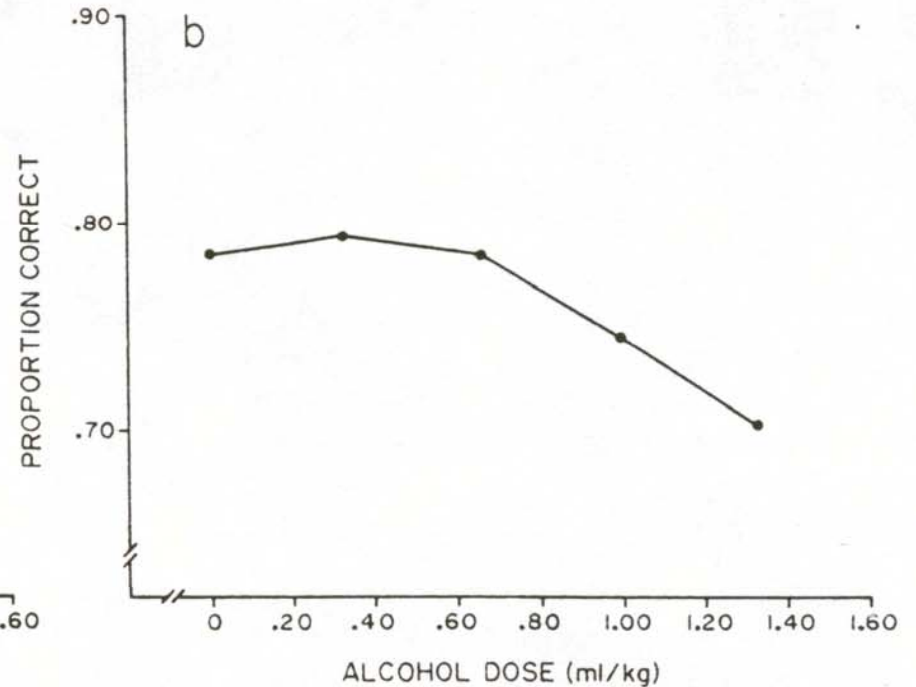
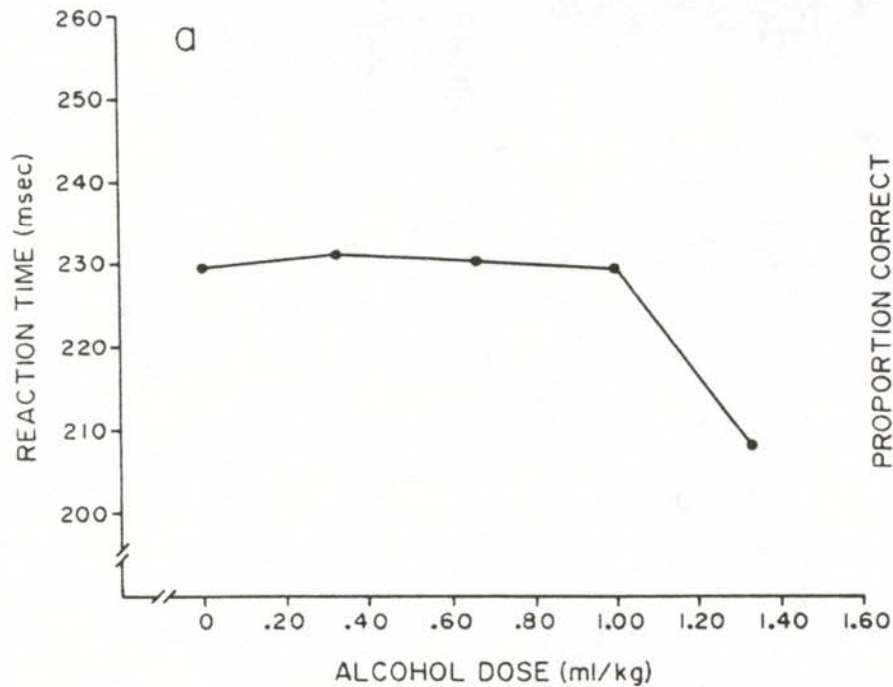
■ Motivation

- ◆ 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.

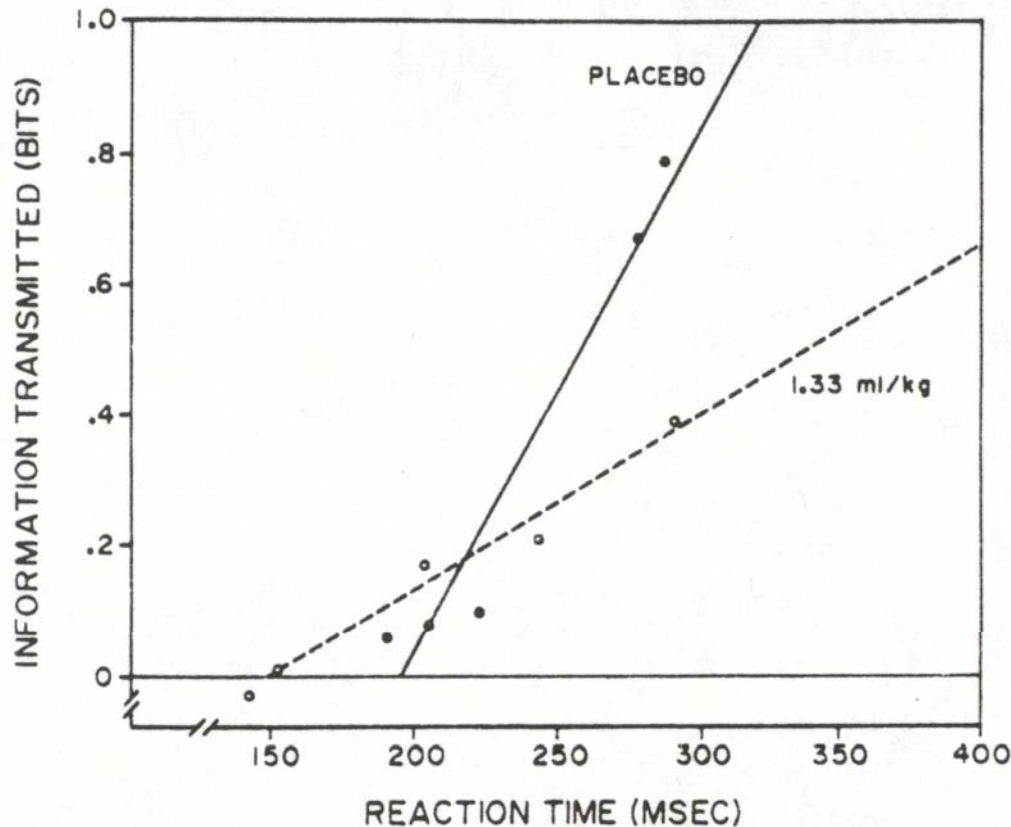
(cont.)

- **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

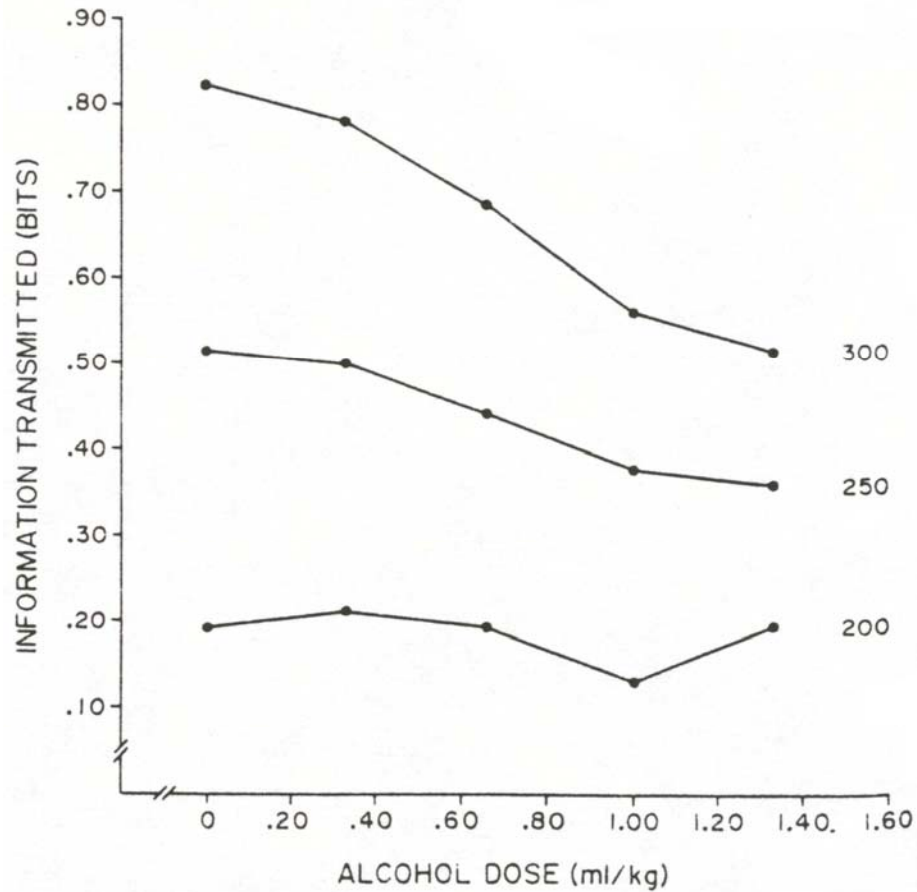


Alcohol and SATF



- 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.