Recognition tasks

Study phase

List of words

"targets"

Test phase

targets	"old"
lures	"new"

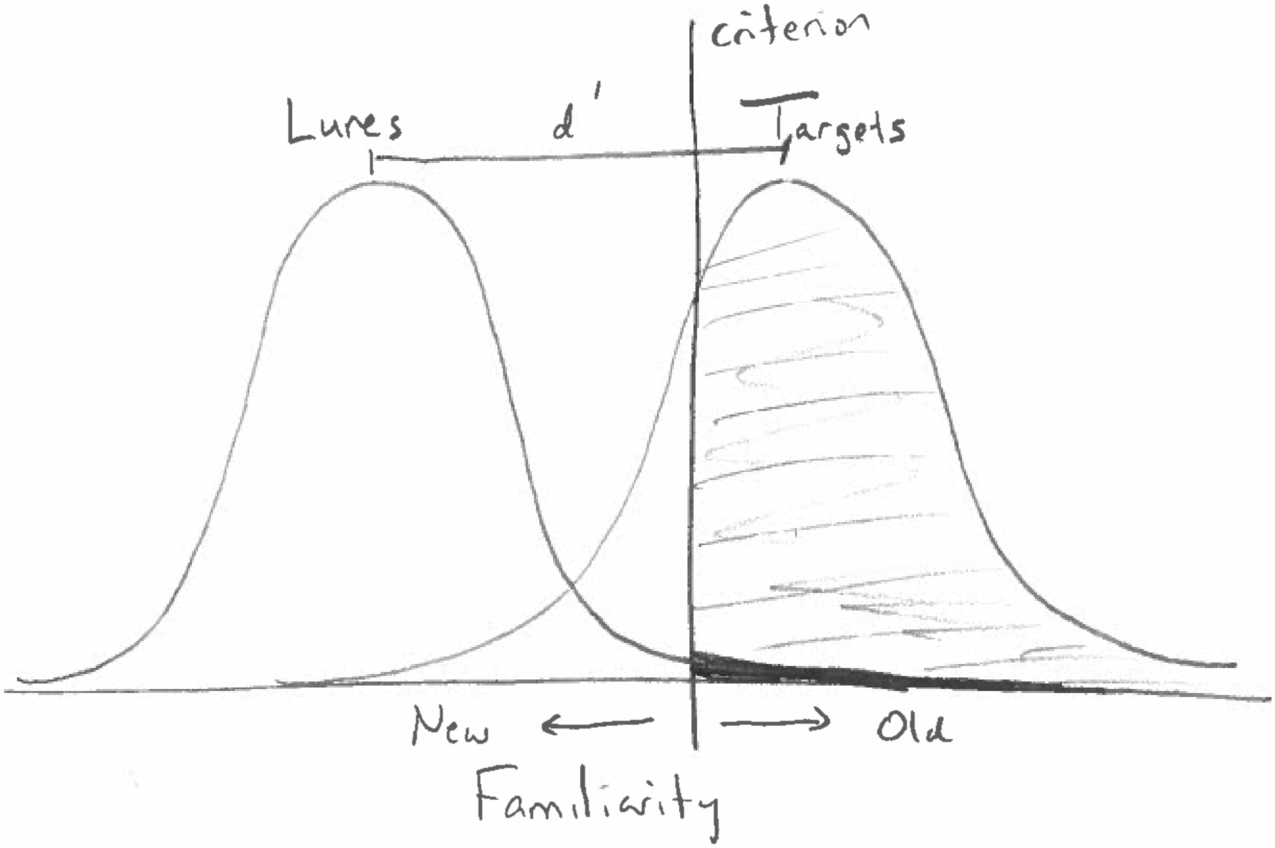
subject responds

Presented at study		"old"	"new"
	Yes	Hit	Miss
	No	FA	Correct rejection

Q: what do I do w/ these data?

SDT (Yonelinas, et al.)

- target / lures represented by distribution of "subjective evidence"



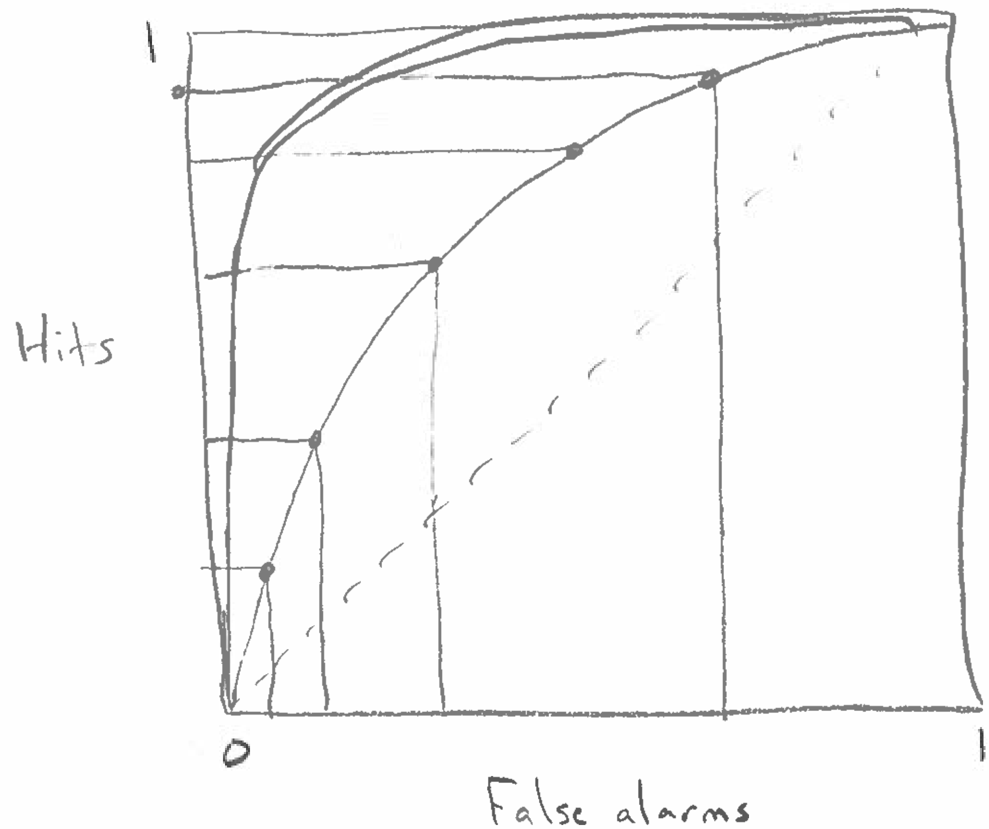
H = "hit rate" = P("old" | target)

FA = "False alarms" = P("old" | lure)

How do we fit SDT model to observed data?

Ans: ROC - "Receiver operator characteristic"

plot $\underbrace{\text{H vs. FA}}_{\text{two-dim}}$ as response criterion shifts



Example data:

- study: 10 target words
- test: 10 targets + 10 lures
- Confidence ratings

  1 = surely new
  2 = less surely new
  3 = barely new
  4 =
  5 =
  6 = surely old

Confidence rating method for ROC

Status	Confidence
~~T~~	~~4~~
~~L~~	~~3~~
~~T~~	~~6~~
~~T~~	~~4~~
~~L~~	~~5~~
~~L~~	~~2~~
~~T~~	~~3~~
~~L~~	~~3~~
~~T~~	~~5~~
~~T~~	~~6~~
~~T~~	~~6~~
~~L~~	~~2~~
~~L~~	~~3~~
~~T~~	~~5~~
~~L~~	~~2~~
~~L~~	~~3~~
~~T~~	~~3~~
~~T~~	~~2~~
~~L~~	~~1~~
~~L~~	~~4~~

$\longrightarrow$ rearrange

T	6	L	5
T	6	L	4
T	6	L	3
T	5	L	3
T	5	L	3
T	4	L	3
T	4	L	2
T	3	L	2
T	3	L	2
T	2	L	1

For each confidence rating $(6, 5, \ldots, 1)$

calculate $\text{Hits} = \dfrac{\# T \geq c}{\# T}$

$$\text{FA} = \frac{\# L \geq c}{\# L}$$

criterion = 6

$H = \frac{3}{10} = 0.3$

$F = \frac{0}{10} = 0$

criterion = 5

$H = \frac{5}{10} = 0.5$

$F = \frac{1}{10} = 0.1$

criterion = 4

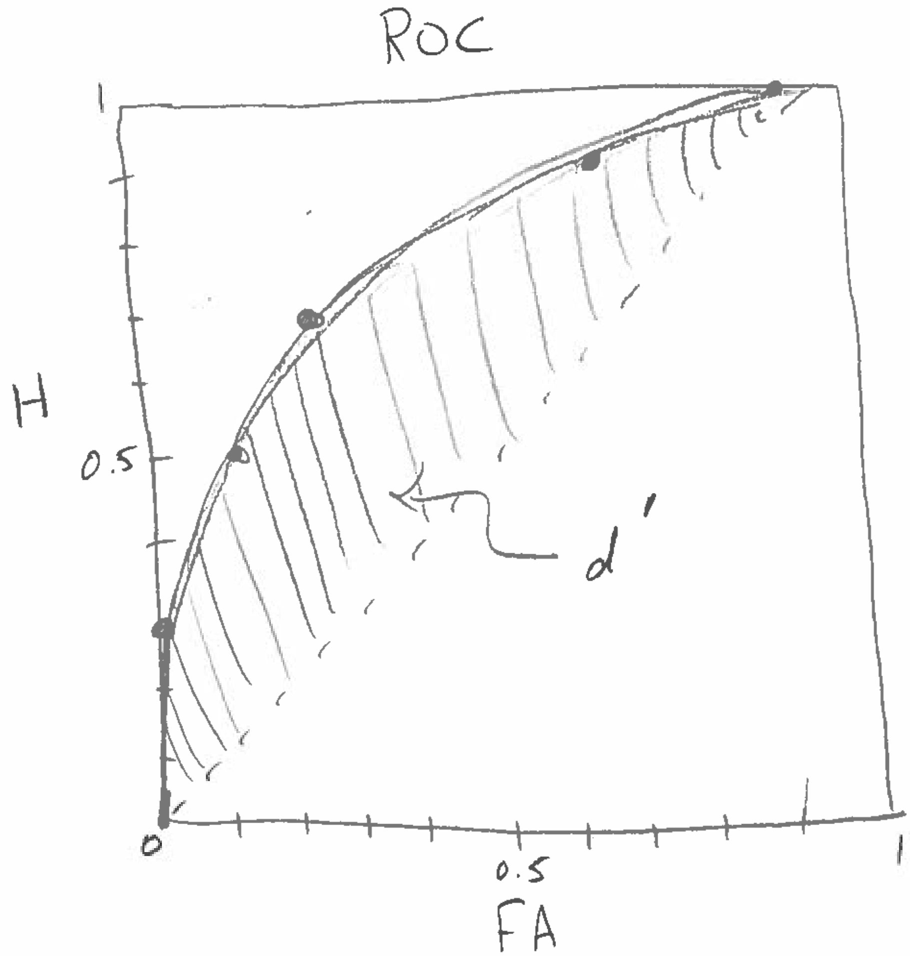
$H = \frac{7}{10} = 0.7$

$F = \frac{2}{10} = 0.2$

criterion = 3

$H = \frac{9}{10} = 0.9$

$F = \frac{6}{10} = 0.6$



criterion = 2

$H = \frac{10}{10} = 1$

$F = \frac{9}{10} = 0.9$

<u>Note:</u> d' = area between curve and diagonal in ROC space.

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Signal-Detection, Threshold, and Dual-Process Models of Recognition Memory: ROCs and Conscious Recollection

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Threshold- and signal-detection-based models have dominated theorizing about recognition memory. Building upon these theoretical frameworks, we have argued for a dual-process model in which conscious recollection (a threshold process) and familiarity (a signal-detection process) contribute to memory performance. In the current paper we assessed several memory models by examining the effects of levels of processing and the number of presentations on recognition memory receiver operating characteristics (ROCs). In general, when the ROCs were plotted in probability space they exhibited an inverted U shape; however, when they were plotted in z space they exhibited a U shape. An examination of the ROCs showed that the dual-process model could account for the observed ROCs, but that models based solely on either threshold or signal-detection processes failed to provide a sufficient account of the data. Furthermore, an examination of subjects' introspective reports using the remember/know procedure showed that subjects were aware of recollection and familiarity and were able to consistently report on their occurrence. The remember/know data were used to accurately predict the shapes of the ROCs, and estimates of recollection and familiarity derived from the ROC data mirrored the subjective reports of these processes.

Threshold- and signal-detection-based theories represent two fundamentally different ways of conceptualizing human memory. With threshold theory, it is assumed that there is some probability that previously studied items will exceed a memory threshold. If an item exceeds the threshold then it is in a discrete memory state. If an item does not exceed the threshold then it is not remembered, but it may still be endorsed as old on the basis of a random guess. Although there are many ways a threshold process may be realized, one plausible way is to assume that memory reflects a discrete retrieval process that provides qualitative information about a previous event. Thus, if we recollect what a person said or what they were wearing, we may be confident that we have met them before. If we cannot retrieve anything about the person then memory has failed, and we either respond that we do not recognize the person or we simply make a random guess.

A very different way of thinking about memory is to assume that there is no discrete memory threshold or state, but rather that memory reflects a type of educated guessing. For example, signal-detection-based models assume that we can place items on a familiarity continuum such that studied items fall on the high end of the continuum and new items fall on the low end of the continuum. By such a model, there is no threshold above which we can be certain that an item was studied, because the famil-

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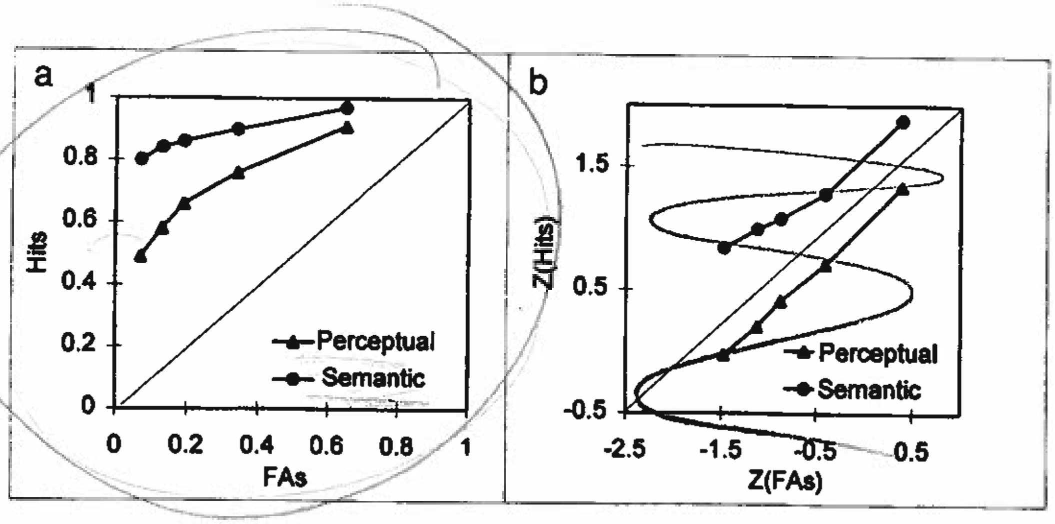

FIG. 3. Recognition memory ROCs from Experiment 1 for perceptually and semantically encoded items plotted on (a) probability coordinates and (b) z coordinates.

words either semantically or perceptually. For the semantic condition, subjects were instructed to judge how pleasant each word was using a 4-point scale, with 4 representing very pleasant words and 1 representing very unpleasant words. For the perceptual condition, subjects counted the number of syllables in each word. Subjects made their responses verbally in both encoding conditions. The order in which the semantic and perceptual tasks was performed was counterbalanced across subjects. Additionally, assignment of the three lists of words to the semantic, perceptual, and new conditions was counterbalanced such that each list served in each condition for an equal number of subjects.

Following the study phase, subjects were given a recognition memory test. All of the studied items and 80 new items were presented one at a time in a random order on an IBM-compatible computer in lowercase letters. The character size of the stimuli was approximately 5 × 5 mm, and the viewing distance was approximately .5 m. Subjects made recognition memory judgments on the computer keyboard using a 6-point confidence scale. Subjects were instructed to respond '6' if they were sure the item was presented in either of the study lists, '5' if they were less sure, and '4' if very unsure. They were instructed to respond '1' if they were sure the word was not presented earlier, '2' if they were less sure and '3' if they were very unsure. Subjects were tested individually, and each session lasted approximately 40 min. The significance level for all statistical tests was $p < .05$ unless otherwise stated.

Results

ROC analysis. Figure 3 presents the average ROCs for the semantic and perceptual encoding conditions plotted in probability space and z space. The ROCs for the semantic encoding condition were consistently higher than those for the perceptual encoding condition, showing that memory performance was better for the semantically processed items. The ROC for the perceptual processing condition exhibited a continuous inverted U shape in probability space and was fit well by a straight line in z space. This pattern has been reported in numerous other studies of recognition memory (e.g., Egan, 1958; Murdock, 1965; Ratcliff, Sheu, & Gronlund, 1992) and