

# Signal detection theory – taste of advanced topics

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# Again experiment with faces

- Participants are shown faces to remember them



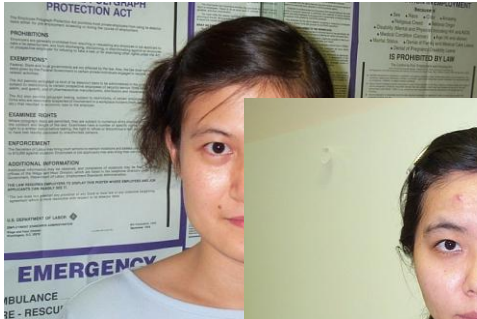
- They are queried after 10minutes and after 7 days

# We add rating of confidence

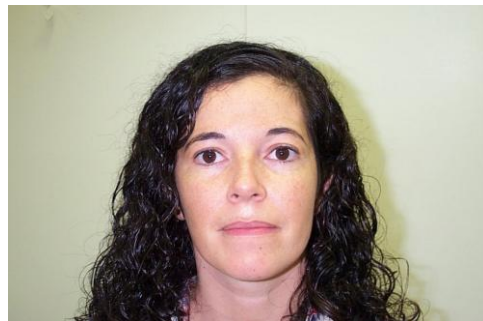
- Participants are shown faces to remember them



old



new



Not sure at all

Somewhat sure

Very sure

# Data

| Type of stimuli | Old       |               |                 | New             |               |           | Total |
|-----------------|-----------|---------------|-----------------|-----------------|---------------|-----------|-------|
|                 | Very sure | Somewhat sure | Not sure at all | Not sure at all | Somewhat sure | Very sure |       |
| 10 minutes      |           |               |                 |                 |               |           |       |
| Old             | 112       | 112           | 72              | 53              | 22            | 4         | 375   |
| New             | 7         | 38            | 50              | 117             | 101           | 62        | 375   |
| 7 days          |           |               |                 |                 |               |           |       |
| Old             | 49        | 94            | 75              | 60              | 75            | 22        | 375   |
| New             | 8         | 37            | 45              | 60              | 113           | 113       | 375   |

If we ignore confidence

|               | <i>10-Minute Delay</i> |             | <i>7-Day Delay</i> |             |
|---------------|------------------------|-------------|--------------------|-------------|
|               | <i>"Yes"</i>           | <i>"No"</i> | <i>"Yes"</i>       | <i>"No"</i> |
| Old ( $S_2$ ) | 296                    | 79          | 218                | 157         |
| New ( $S_1$ ) | 95                     | 280         | 90                 | 285         |

| <i>10-Minute Delay</i> | <i>7-Day Delay</i>  |
|------------------------|---------------------|
| $H = 296/375 = .79$    | $H = 218/375 = .58$ |
| $F = 95/375 = .25$     | $F = 90/375 = .24$  |
| $d' = 1.48$            | $d' = 0.91$         |

# With confidence rating

- Finer division allows us to compute multiple  $d'$  for different thresholds

| Type of stimuli |           | Old           |                 | New             |               |           | Total |
|-----------------|-----------|---------------|-----------------|-----------------|---------------|-----------|-------|
|                 | Very sure | Somewhat sure | Not sure at all | Not sure at all | Somewhat sure | Very sure |       |
|                 |           | 10 minutes    |                 |                 |               |           |       |
| Old             | 112       | 112           | 72              | 53              | 22            | 4         | 375   |
| New             | 7         | 38            | 50              | 117             | 101           | 62        | 375   |
|                 |           | 7 days        |                 |                 |               |           |       |
| Old             | 49        | 94            | 75              | 60              | 75            | 22        | 375   |
| New             | 8         | 37            | 45              | 60              | 113           | 113       | 375   |

# With confidence rating

- Or this

| Type of stimuli | Old       |               |                 | New             |               |           | Total |
|-----------------|-----------|---------------|-----------------|-----------------|---------------|-----------|-------|
|                 | Very sure | Somewhat sure | Not sure at all | Not sure at all | Somewhat sure | Very sure |       |
| 10 minutes      |           |               |                 |                 |               |           |       |
| Old             | 112       | 112           | 72              | 53              | 22            | 4         | 375   |
| New             | 7         | 38            | 50              | 117             | 101           | 62        | 375   |
| 7 days          |           |               |                 |                 |               |           |       |
| Old             | 49        | 94            | 75              | 60              | 75            | 22        | 375   |
| New             | 8         | 37            | 45              | 60              | 113           | 113       | 375   |

# With confidence rating

- Or this, in general, we have  $n-1$  division lines

| Type of stimuli | Old       |               |                 |                 | New           |           | Total |
|-----------------|-----------|---------------|-----------------|-----------------|---------------|-----------|-------|
|                 | Very sure | Somewhat sure | Not sure at all | Not sure at all | Somewhat sure | Very sure |       |
| 10 minutes      |           |               |                 |                 |               |           |       |
| Old             | 112       | 112           | 72              | 53              | 22            | 4         | 375   |
| New             | 7         | 38            | 50              | 117             | 101           | 62        | 375   |
| 7 days          |           |               |                 |                 |               |           |       |
| Old             | 49        | 94            | 75              | 60              | 75            | 22        | 375   |
| New             | 8         | 37            | 45              | 60              | 113           | 113       | 375   |

# How to compute d's

- We start with counts

|                        | <i>"Old"</i> |            |            | <i>"New"</i> |            |            | <i>Total</i> |
|------------------------|--------------|------------|------------|--------------|------------|------------|--------------|
|                        | <i>"3"</i>   | <i>"2"</i> | <i>"1"</i> | <i>"1"</i>   | <i>"2"</i> | <i>"3"</i> |              |
| <i>10-Minute Delay</i> |              |            |            |              |            |            |              |
| Old                    | 112          | 112        | 72         | 53           | 22         | 4          | 375          |
| New                    | 7            | 38         | 50         | 117          | 101        | 62         | 375          |
| <i>7-Day Delay</i>     |              |            |            |              |            |            |              |
| Old                    | 49           | 94         | 75         | 60           | 75         | 22         | 375          |
| New                    | 8            | 37         | 45         | 60           | 113        | 113        | 375          |

# How to compute d's

- Then we compute relative frequency (to row total)

|                        | <i>"Old"</i> |            |            | <i>"New"</i> |            |            | <i>Total</i> |
|------------------------|--------------|------------|------------|--------------|------------|------------|--------------|
|                        | <i>"3"</i>   | <i>"2"</i> | <i>"1"</i> | <i>"1"</i>   | <i>"2"</i> | <i>"3"</i> |              |
| <i>10-Minute Delay</i> |              |            |            |              |            |            |              |
| Old                    | .299         | .299       | .192       | .141         | .059       | .011       | 1.00         |
| New                    | .019         | .101       | .133       | .312         | .269       | .165       | 1.00         |
| <i>7-Day Delay</i>     |              |            |            |              |            |            |              |
| Old                    | .131         | .251       | .200       | .160         | .200       | .059       | 1.00         |
| New                    | .021         | .099       | .120       | .160         | .301       | .301       | 1.00         |

# How to compute d's

- We compute cumulative relative frequency

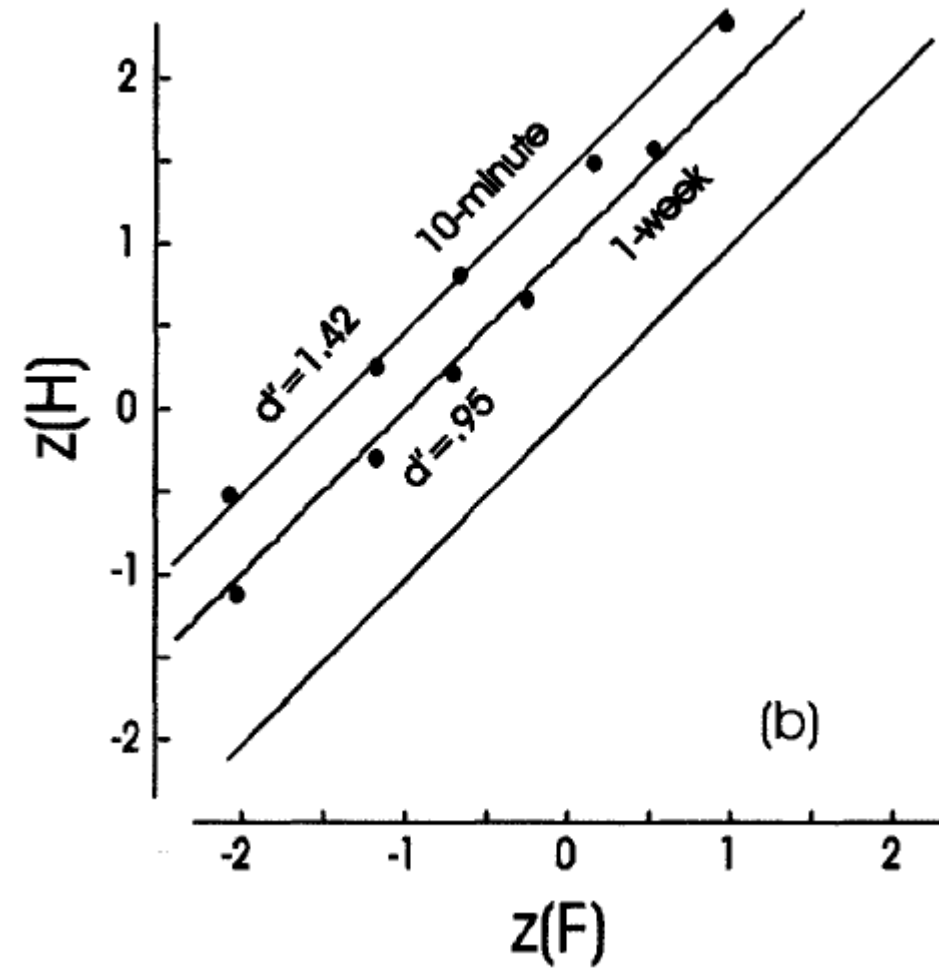
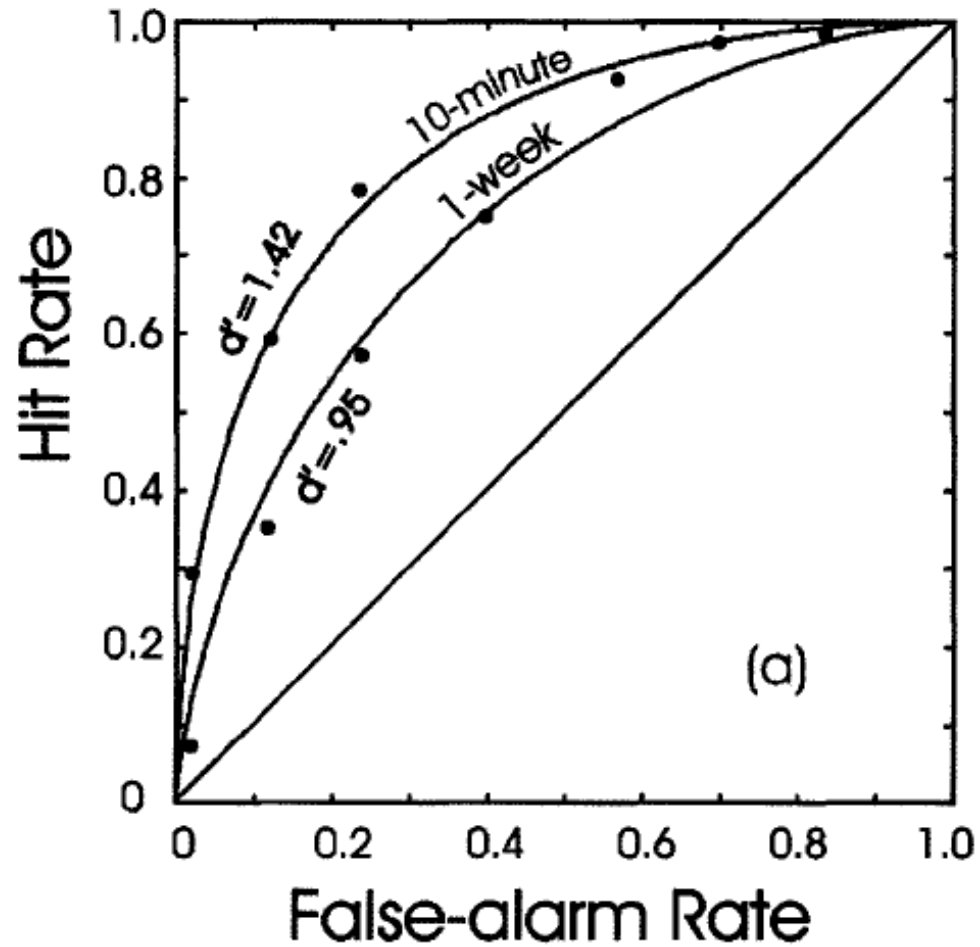
|                        | <i>"Old"</i> |            |            | <i>"New"</i> |            |            |
|------------------------|--------------|------------|------------|--------------|------------|------------|
|                        | <i>"3"</i>   | <i>"2"</i> | <i>"1"</i> | <i>"1"</i>   | <i>"2"</i> | <i>"3"</i> |
| <i>10-Minute Delay</i> |              |            |            |              |            |            |
| Old                    | .299         | .598       | .790       | .931         | .990       | 1.00       |
| New                    | .019         | .120       | .253       | .565         | .834       | 1.00       |
| <i>7-Day Delay</i>     |              |            |            |              |            |            |
| Old                    | .131         | .382       | .582       | .742         | .942       | 1.00       |
| New                    | .021         | .120       | .240       | .400         | .701       | 1.00       |

# How to compute $d'$ s

- And finally, we convert cumulative relative frequency to z-scores and corresponding  $d'$

|                        | "Old"  |        |        | "New"  |       |
|------------------------|--------|--------|--------|--------|-------|
|                        | "3"    | "2"    | "1"    | "1"    | "2"   |
| <i>10-Minute Delay</i> |        |        |        |        |       |
| Old                    | -0.527 | 0.232  | 0.807  | 1.484  | 2.327 |
| New                    | -2.081 | -1.175 | -0.665 | 0.164  | 0.970 |
| $d'$                   | 1.554  | 1.407  | 1.472  | 1.320  | 1.357 |
| <i>7-Day Delay</i>     |        |        |        |        |       |
| Old                    | -1.121 | -0.301 | 0.207  | 0.649  | 1.573 |
| New                    | -2.037 | -1.175 | -0.706 | -0.253 | 0.527 |
| $d'$                   | 0.916  | 0.874  | 0.913  | 0.902  | 1.046 |

In form ROC curve



# Another example

- Recognition of low-frequency and high frequency words.

