





TEORIA DA DETECÇÃO DE SINAL E SUAS APLICAÇÕES

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Teoria Detecção de Sinal - TDS

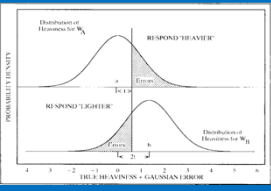
- Surge durante a II Guerra Mundial: detecção de aeronaves por radares.
- Um modelo estatístico de tomada de decisão e método de análise de dados coletados em condições que envolvem incertezas.
- Hoje, TDS é amplamente aplicada na psicologia (psicofísica e tomada de decisão), medicina, radiologia e inteligência artificial.



General Article

REDISCOVERING THE PAST: Gustav Fechner and Signal Detection Theory

By Stephen W. Link



Fechner (~1850)
"Teoria discriminativa"

Thurstone (1927)
"Lei dos Julgamentos Comparativos"

Link (1994). *Psychological Science*, 5(6), 335-340.

Teoria de Detecção de Sinal - Psicofísica

O que acontece se um observador for recompensado ou punido se a resposta for correta ou errada ao detectar um estímulo?



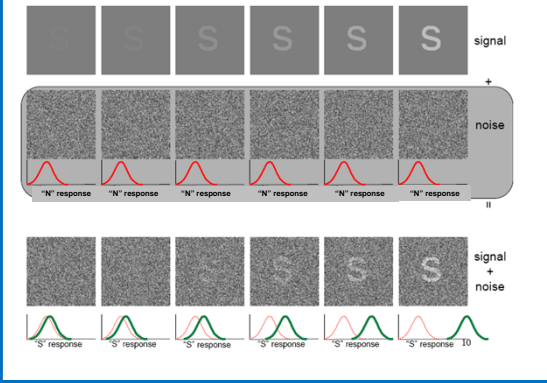
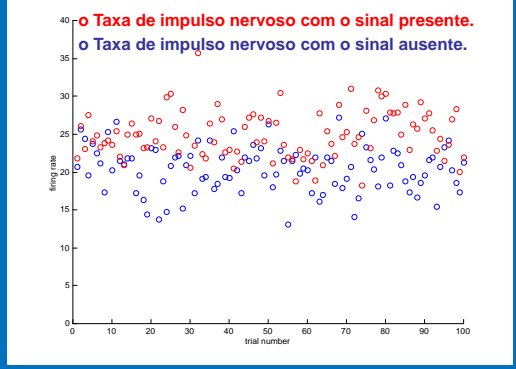
Swets, Green, Tanner, Birdsall - décadas 50 e 60.

Contribuições:

- índice de sensibilidade (d')
- critério de decisão (β)
- curva ROC - 'Receiver Operating Characteristic'

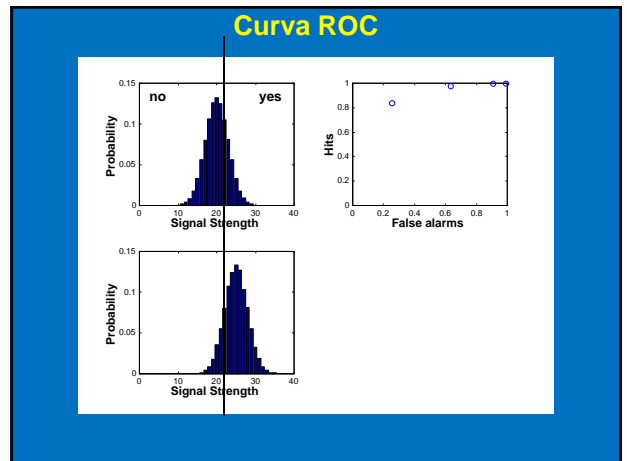
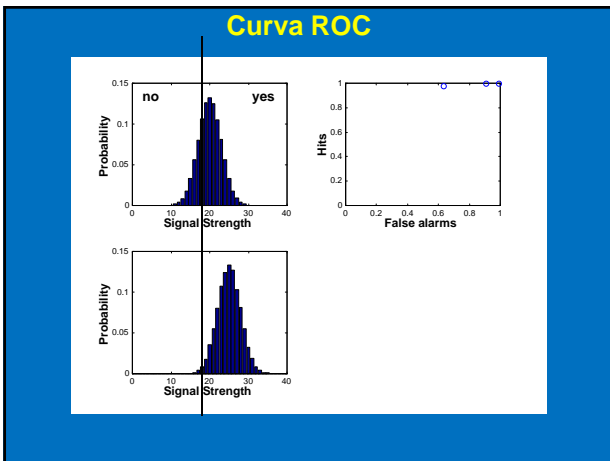
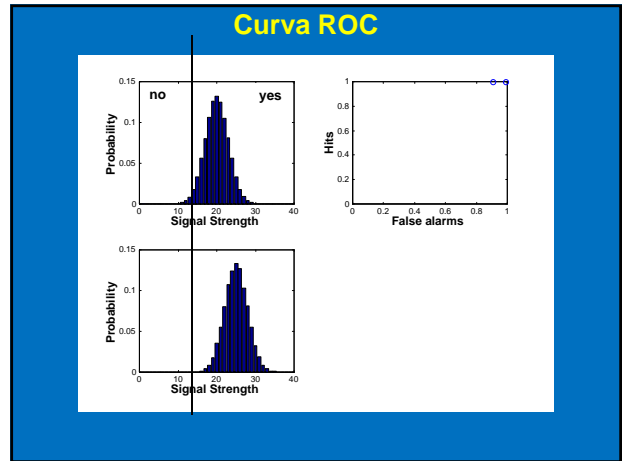
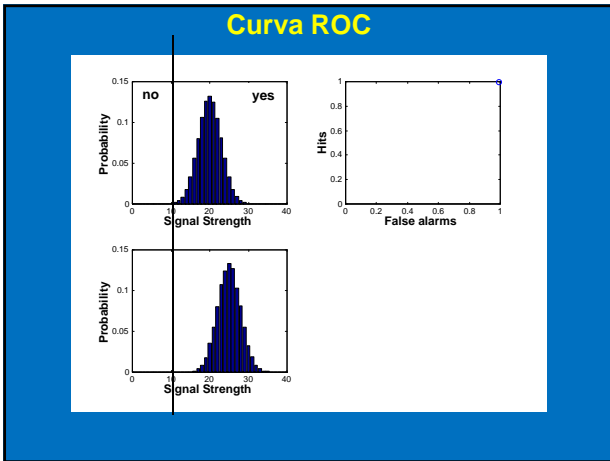
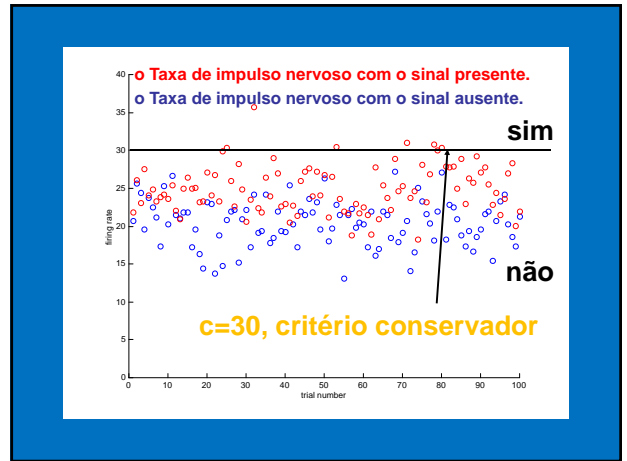
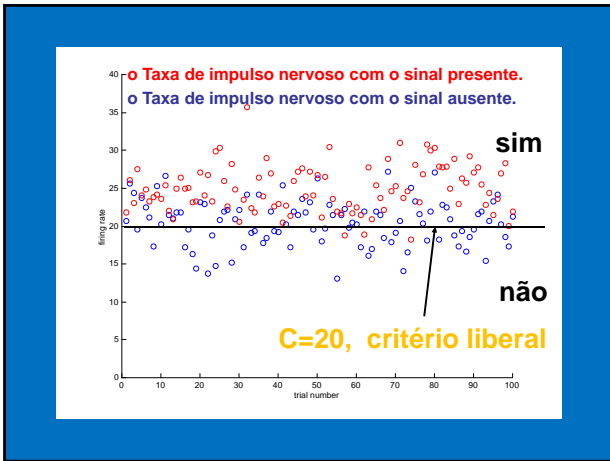
Tanner, W P & Swets, J A (1954). *Psych. Rev.*, 61, 401-409.
Swets, J A, Tanner, W P, Birdsall, T.G (1961). *Psych. Rev.*, 68, 301-340.
Swets, J A (ed), (1964). *Signal Detection and Recognition by humans observers*. Wiley.
Green, D M & Swets, J A (1966) *Signal Detection Theory and Psychophysics*. Wiley.

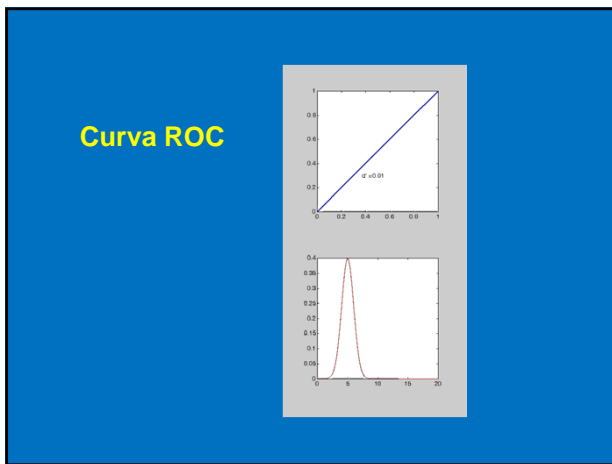
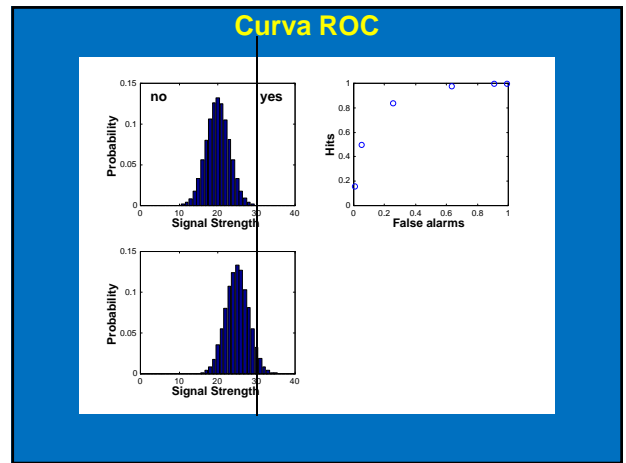
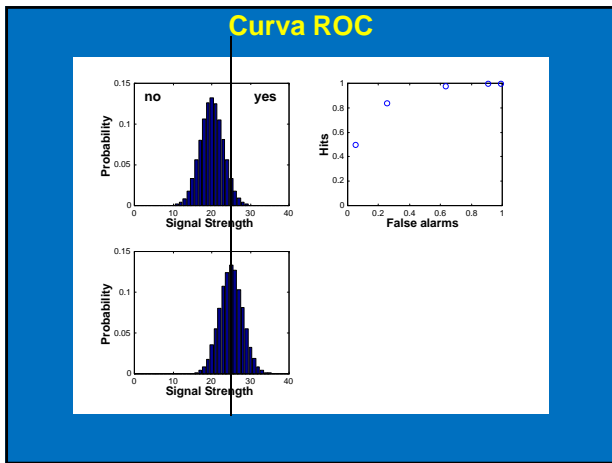
Além dos fatores sensoriais, fatores motivacionais afetam a decisão de resposta, e consequentemente, os valores dos limiares.

o Taxa de impulso nervoso com o sinal presente.

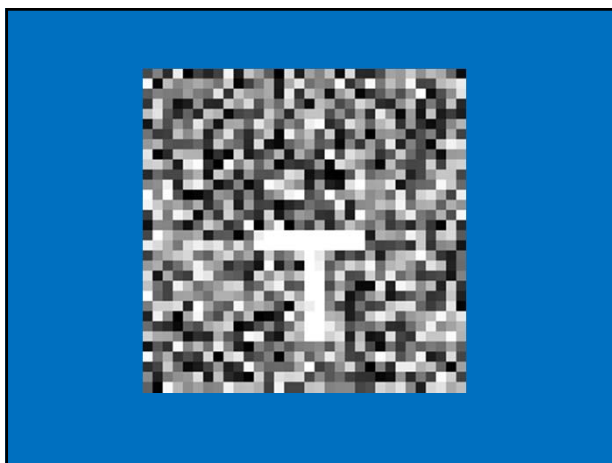
o Taxa de impulso nervoso com o sinal ausente.

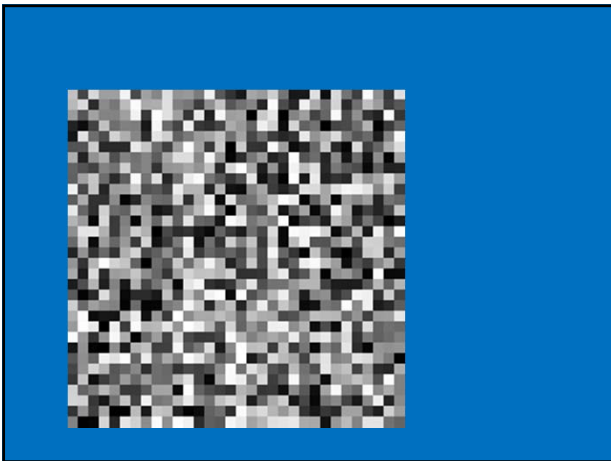
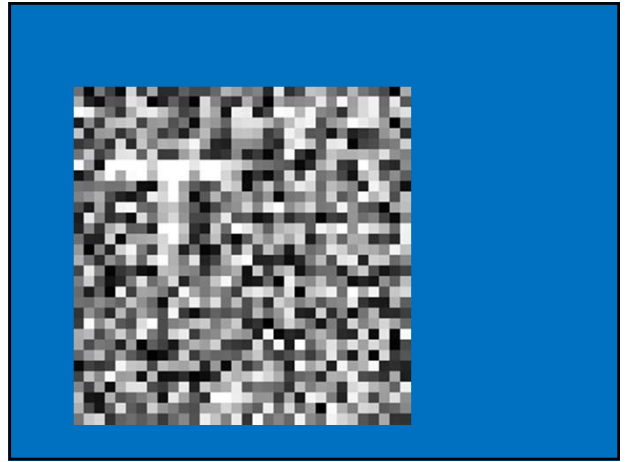
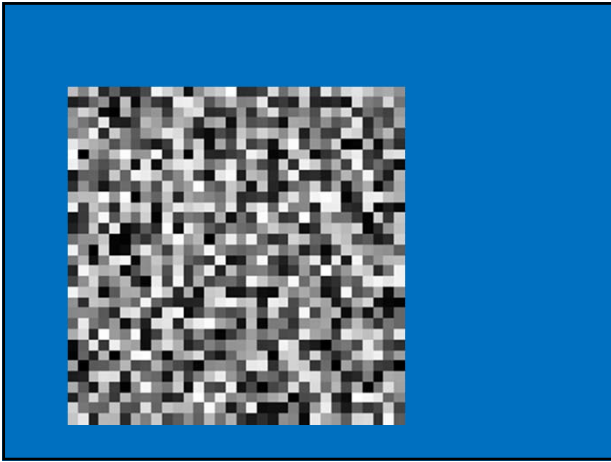




Método SIM-NÃO

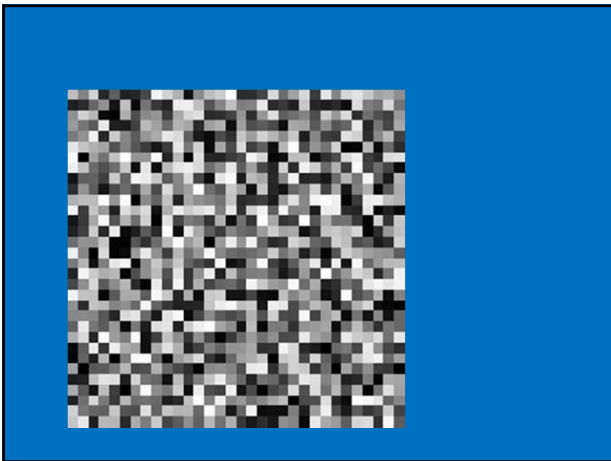
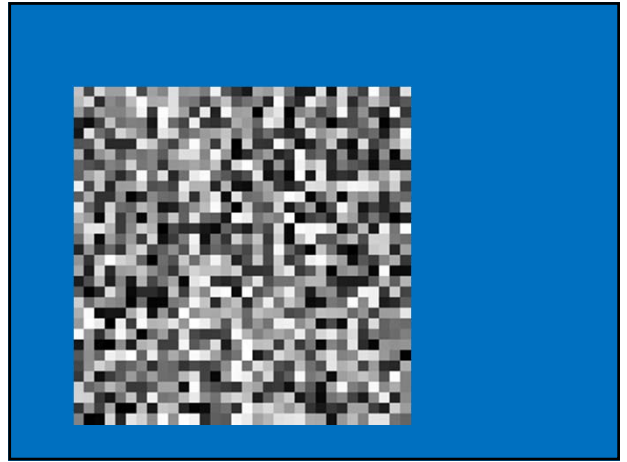
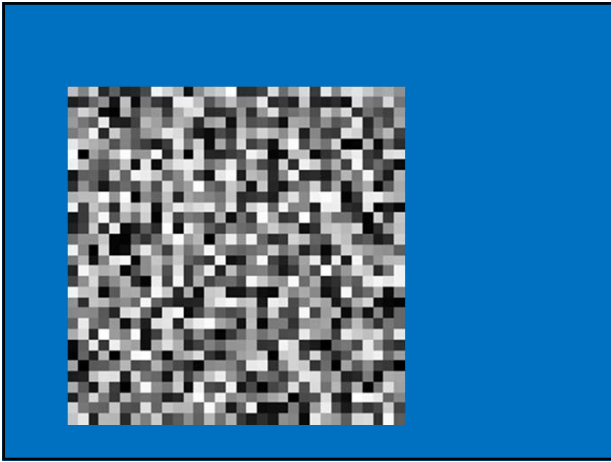
Estímulo presente	Estímulo ausente
	
Respostas	
Sim (acerto)	Sim (falso alarme)
Não (omissão)	Não (rejeição correta)





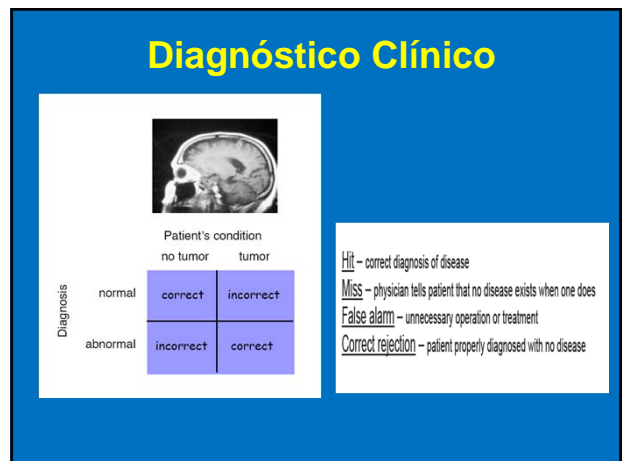
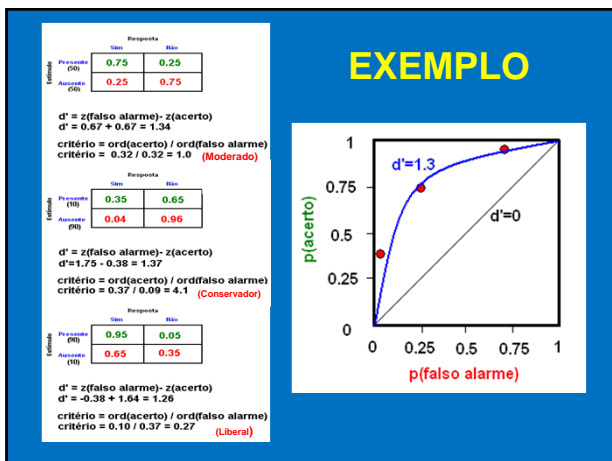
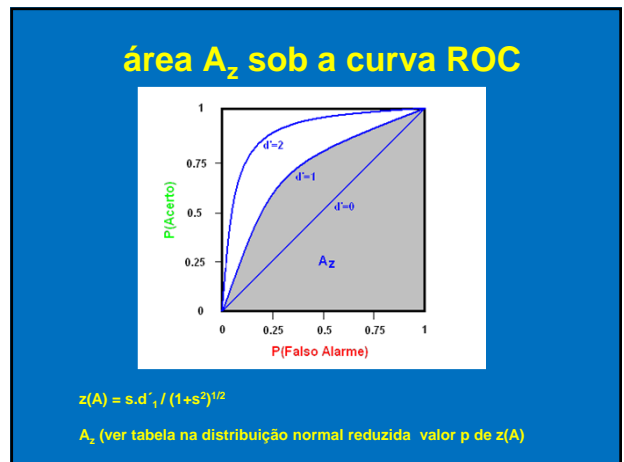
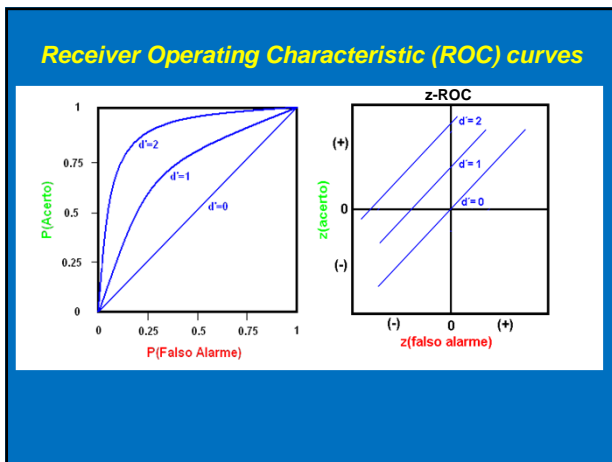
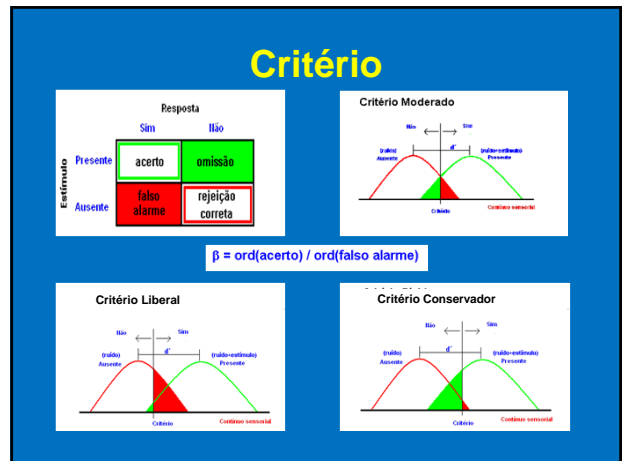
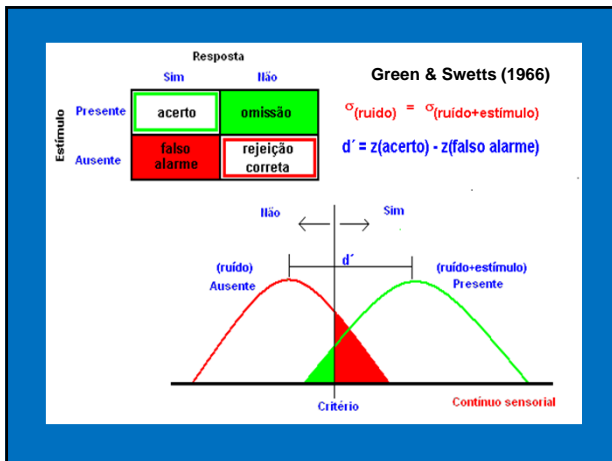
**“T” estava presente?
SIM ou NÃO**

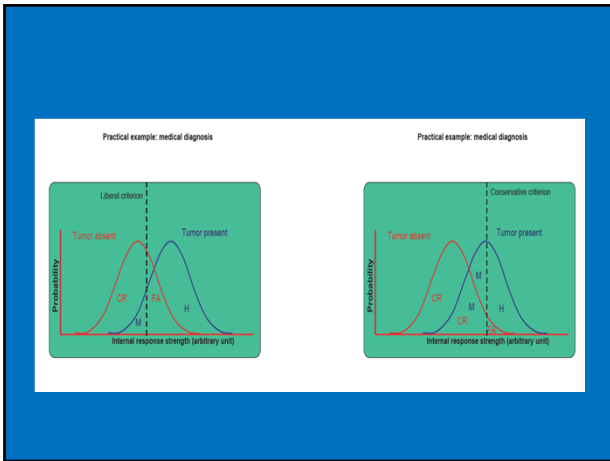




**“T” estava presente?
SIM ou NÃO**







Basic Principles of ROC Analysis

Charles E. Metz
Seminars in Nuclear Medicine, Vol. VIII, No. 4 (October), 1978

Table 1. Definitions of, and Relationships Among, the Various Decision Performance Indices Described in the Text

Definitions	Relationships
TPF = Sensitivity = $P(T+ D+)$	$TPF + FNF = P(T+ D+) + P(T- D+) = 1$
FPF = $1 - (\text{Specificity}) = P(T- D-)$	$TNF + FPF = P(T- D-) + P(T+ D-) = 1$
TNF = Specificity = $P(T- D-)$	Accuracy = Sensitivity $\times P(D+)$
FNF = $1 - \text{Sensitivity} = P(T- D+)$	+ Specificity $\times P(D-)$
Disease Prevalence = $P(D+)$	= $TPF \times P(D+) + TNF \times P(D-)$
	= $(P(T+ D+) \times P(D+) + P(T- D-) \times P(D-))$

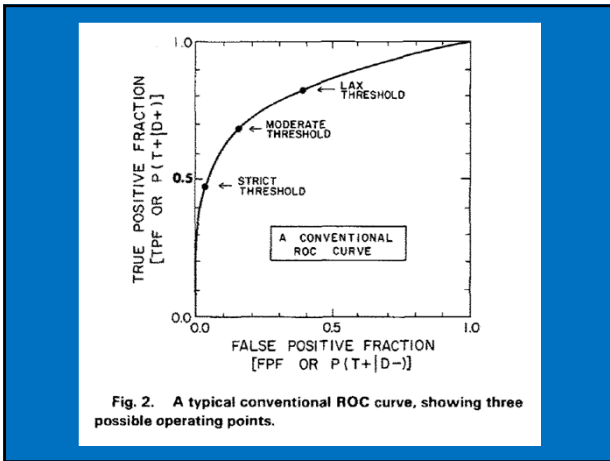


Table 2. Decision Data and Calculated Indices for Hypothetical Test A*

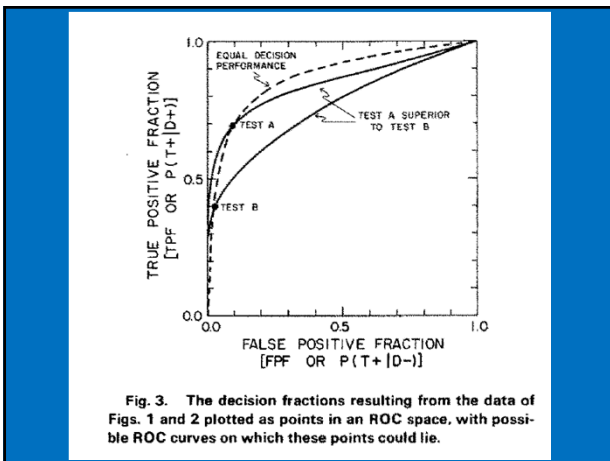
Actual State	Test Result (Diagnosis)		Total Actual States
	Positive (T+)	Negative (T-)	
Positive (D+)	140 (TP)	60 (FN)	200 actually positive
Negative (D-)	100 (FP)	900 (TN)	1000 actually negative
Total test results (diagnosis)	240 positive decisions	960 negative decisions	

*Total cases, 1200.
Calculated indices:
 $TPF = 140/200 = 0.70$; $FNF = 1 - TPF = 0.30$
 $FPF = 100/1000 = 0.10$; $TNF = 1 - FPF = 0.90$
 $P(D+) = 200/1200 = 0.17$; $P(D-) = 1 - P(D+) = 0.83$
 Accuracy = $TPF \times P(D+) + TNF \times P(D-) = 0.87$

Table 3. Decision Data and Calculated Indices for Hypothetical Case B*

Actual State	Test Result (Diagnosis)		Total Actual States
	Positive (T+)	Negative (T-)	
Positive (D+)	80 (TP)	120 (FN)	200 actually positive
Negative (D-)	40 (FP)	960 (TN)	1000 actually negative
Total test results (diagnosis)	120 positive decisions	1080 negative decisions	

*Total cases, 1200.
Calculated indices:
 $TPF = 80/200 = 0.40$; $FNF = 1 - TPF = 0.60$
 $FPF = 40/1000 = 0.04$; $TNF = 1 - FPF = 0.96$
 $P(D+) = 200/1200 = 0.17$; $P(D-) = 1 - P(D+) = 0.83$
 Accuracy = $TPF \times P(D+) + TNF \times P(D-) = 0.87$

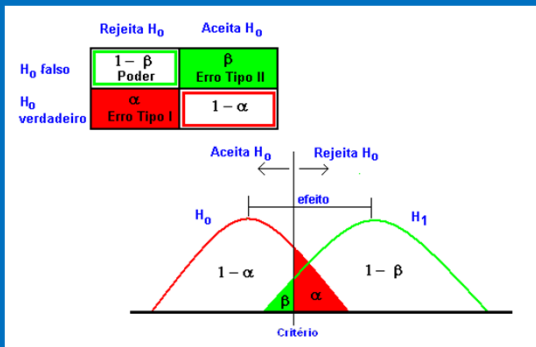


DIAGNÓSTICO CLÍNICO

Resultado do Teste

		Resultado do Teste	
		Positivo	Negativo
Diagnóstico Real (Gold Standard)	Positivo	Verdadeiro Positivo	Falso Negativo (FN)
	Negativo	Falso Positivo (FP)	Verdadeiro Negativo

TESTE DE HIPÓTESES - ESTATÍSTICA



Aplicações Diversas

Sensação e Percepção,
Aprendizagem, Memória e Cognição

Avaliação de performance
Avaliação diagnóstica

Exemplo 1

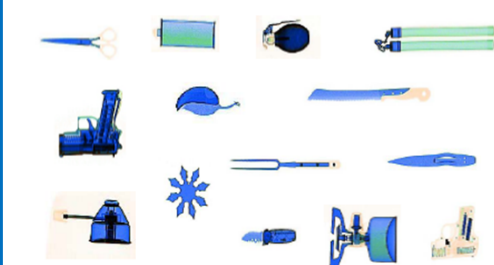
Evaluation and Certification of Airports
Security Screeners

Adrian Schwaninger

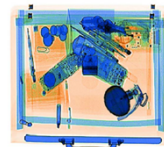
University of Zurich
Visual Cognition Research Group
www.psychologie.unizh.ch/vicoreg



Prohibited Items Test (PIT)

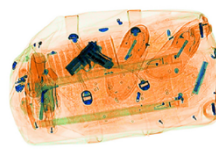


Prohibited Items Test (PIT)

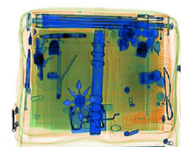


www.psychologie.unizh.ch/vicoreg

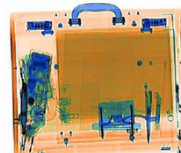
Prohibited Items Test (PIT)

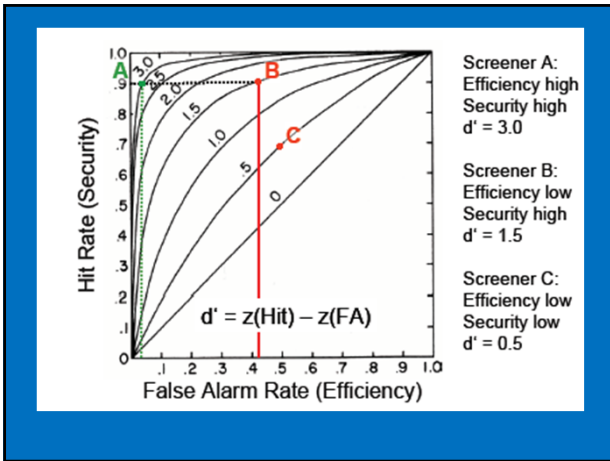


Prohibited Items Test (PIT)



Prohibited Items Test (PIT)





What Makes a Good Test - Validity

- The Hit rate alone does not tell you much. The hit rate it is not a valid measure. (Simply judging most bags as being NOT OK can also result in a high hit rate)
- Signal detection theory provides valid measures of detection performance (d' , Δm , Az)

Exemplo 2

Efeito de frequências espaciais no reconhecimento de faces pelos hemisférios cerebrais direito e esquerdo de homens e mulheres

Lina M. Perilla-Rodriguez
Sérgio S. Fukusima

Universidade de São Paulo, Ribeirão Preto

Participantes Destros: HD (10F,10M) HE (10F,10M) (total = 40)

Etapa 1: Memorização de faces alvos sem filtragem (n=14)

Etapa 2: Três sessões, uma para cada condição de filtragem

	original	passa-baixo	passa-alto	
Alvos:	14	14	14	(mesmas)
Distratores:	14	14	14	(diferentes)

Método

Equipamento (Tripathy et al., 1995)

Hemisfério Esquerdo

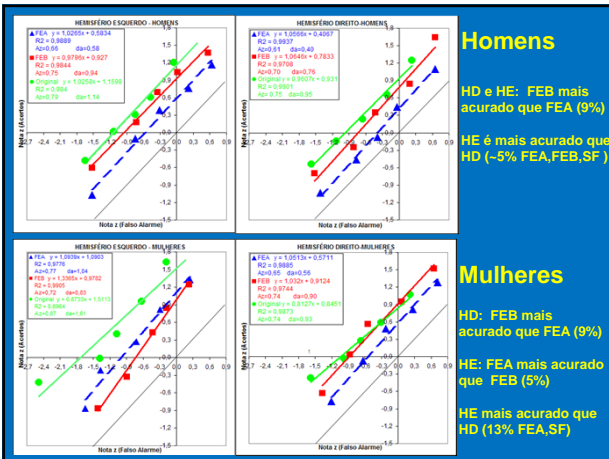
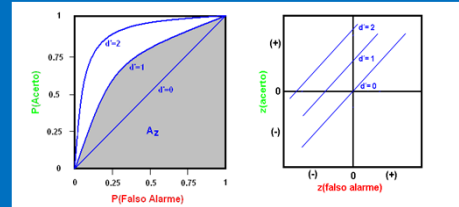
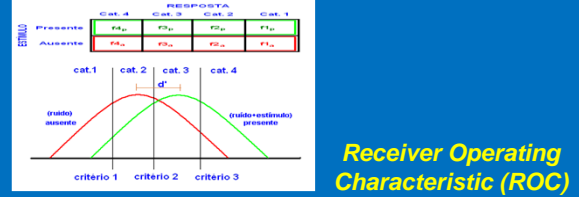
Etapa 3: Tarefa (Confidence Rating -Teoria de Detecção de Sinal)

resposta e tempo de resposta

300ms

fixação

Confidence Rating Method



Exemplo 3

Reconhecimento de imagens com conteúdo emocional em apresentações subliminares

Alunos de graduação – PGE III (2009):
 André V. Komatsu
 Léo P. Salmin
 Paula M. S. Theodoro
 Pedro L. Bevilacqua
 Rafael H. L. Cardoso

Alunos de pós-graduação:
 Leonardo G. Bernardino
 Bruno Marinho de Sousa
 Rui de Moraes Jr.

Orientador: Sérgio S. Fukusima

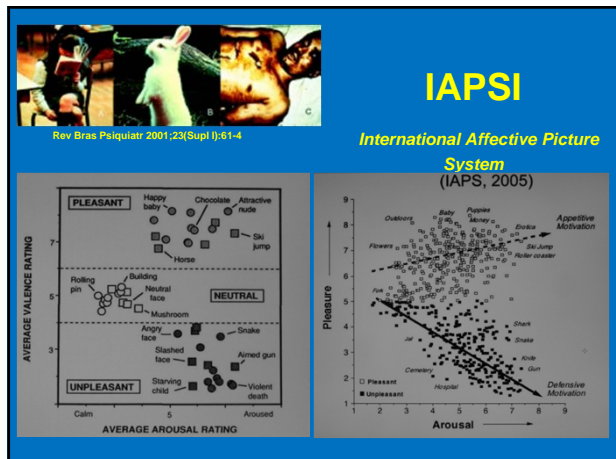
Objetivo: Investigar reconhecimentos de estímulos de valências emocionais positivas e negativas em apresentações subliminares

Estímulos – International Affective Picture System (IAPS), 2008*

- Valência positiva
 7 memorizadas (5910, 7340, 8041, 8210, 8501, 4669, 4689) – tempo livre
 7 novas (4611, 4653, 7230, 7450, 8190, 8370, 8380)
- Valência negativas
 7 memorizadas (3060, 3140, 6360, 9265, 9320, 9910, 2730) – tempo livre
 7 novas (3168, 6260, 9300, 9340, 9410, 9420, 9600)

* Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2008). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8. University of Florida, Gainesville, FL.

Caráter exploratório



MÉTODO

Participantes: 15 M e 15F

Método "Confidence Rating" – Teoria de Detecção de Sinal

Exposição subliminar das imagens: 20 ms

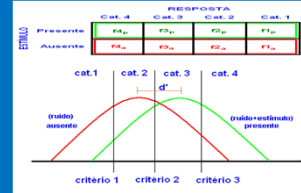
Respostas – 6 categorias :

- (6) reconheço com certeza
- (5) reconheço, mas tenho dúvida
- (4) reconheço, mas tenho muita dúvida
- (3) não reconheço, mas tenho muita dúvida
- (2) não reconheço, mas tenho dúvida
- (1) não reconheço com certeza

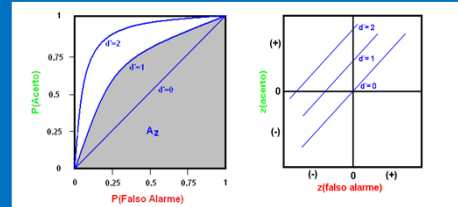
Curva ROC – Teoria de Detecção de Sinal

Tempo de resposta

Confidence Rating Method



Receiver Operating Characteristic (ROC)



Resultados

