OUTLINE

I) Brief Review of ROC paradigm
(receiver operating characteristic for dx tests)

II) Location-specific ROC paradigm (LROC)

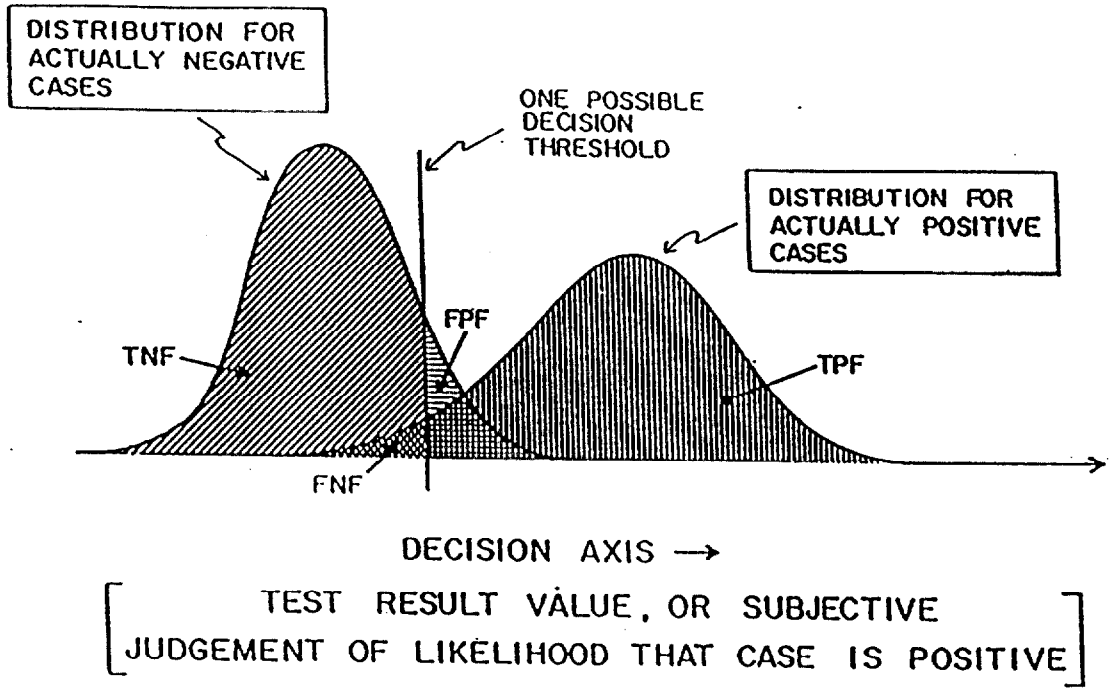
III) Reader variability & paradigm of "reader study"
(multiple-reader, multiple-case MRMC ROC)

IV) Components of variance available from
Analysis of MRMC ROC

V) Relevance to the present clinical study

BY R.F. WAGNER, Ph.D.

1) The ROC Paradigm



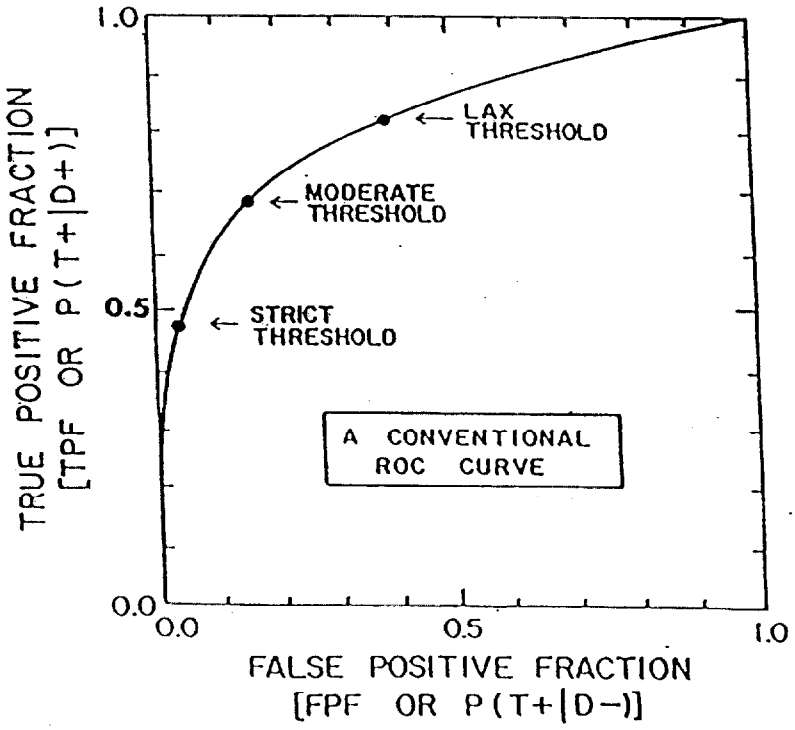
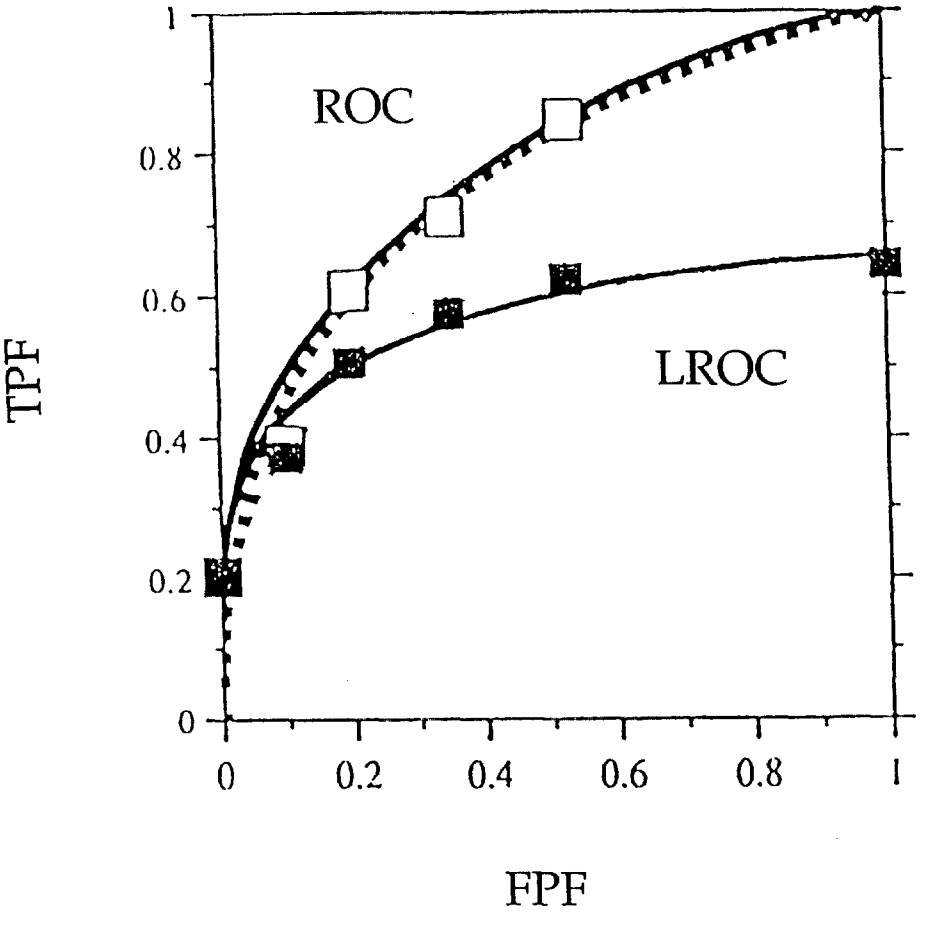


Fig. A typical conventional ROC curve, showing three possible operating points.

Localization ROC (LROC)



Correct location identification required

Monotonic relation between ROC and LROC

Parametric models and fitting software exist
(task of validating model & fitting still in progress)

No software for testing *differences* between systems

Thus – LROC culture still in maturation stage

The Multiple-Reader, Multiple-Case (MRMC) ROC Paradigm

Every reader reads *every case* (and where practical) in both modalities

Can then model and account for the following multivariate ROC Accuracy parameters:

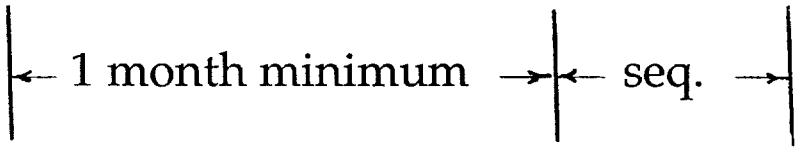
correlated across modalities:
- Case component of variance
- Reader component " "
- Reader-by-case component

*un*correlated across modalities:
- Modality-by-case
- Reader-by-case
- Reader "jitter"

contribute to error bars on *difference* of modalities

"modalities" here = w/o computer *vs* with computer

Reading Conditions



Independent without computer	Sequential w/o computer	Sequential with computer

Which is the baseline (or reference) mode:
Independent without computer
or Sequential without computer ?

Independent: Corresponds to current reality

Sequential: Provides sensitive probe of difference

Error bars will be tighter with "Sequential" mode
(a frequently used experimental design tool)

One may thus also argue
in favor of "Sequential w/o computer" as baseline

Analysis* of the ROC data
in terms of these variance components showed:

For Sequential Reading Condition (all cases) -

the reader components
that are correlated across modalities
were higher
(expected naturally)

the reader components
that are *un*correlated across modalities
were *lower* (**)

For Independent Reading Condition (all cases) –
vice versa . . .

. . . but *total* reader variance was the *same*
for both reading conditions

Thus, the Sequential Reading Condition
takes advantage of a well-known design lever (**)
yielding tighter error bars

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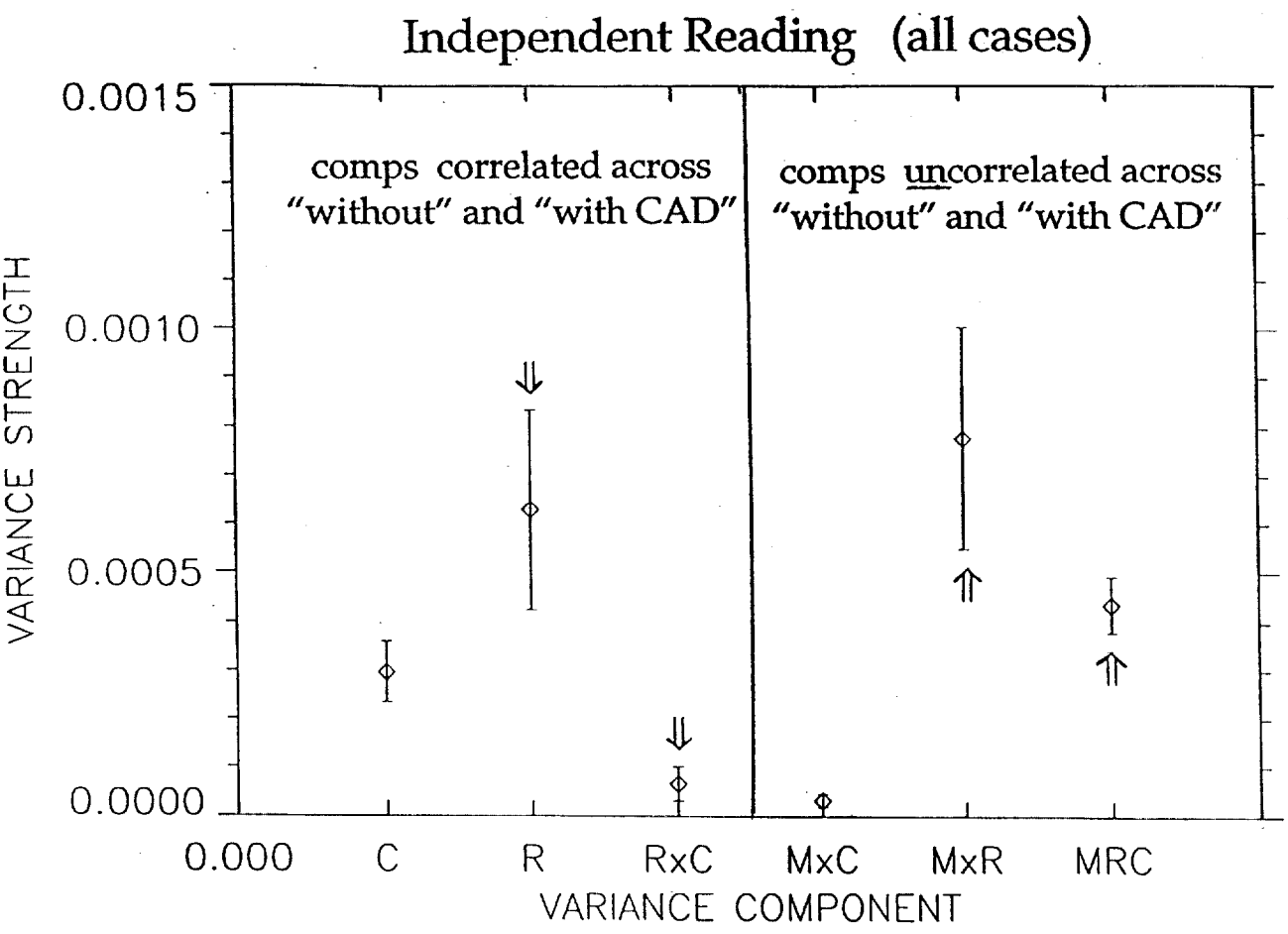
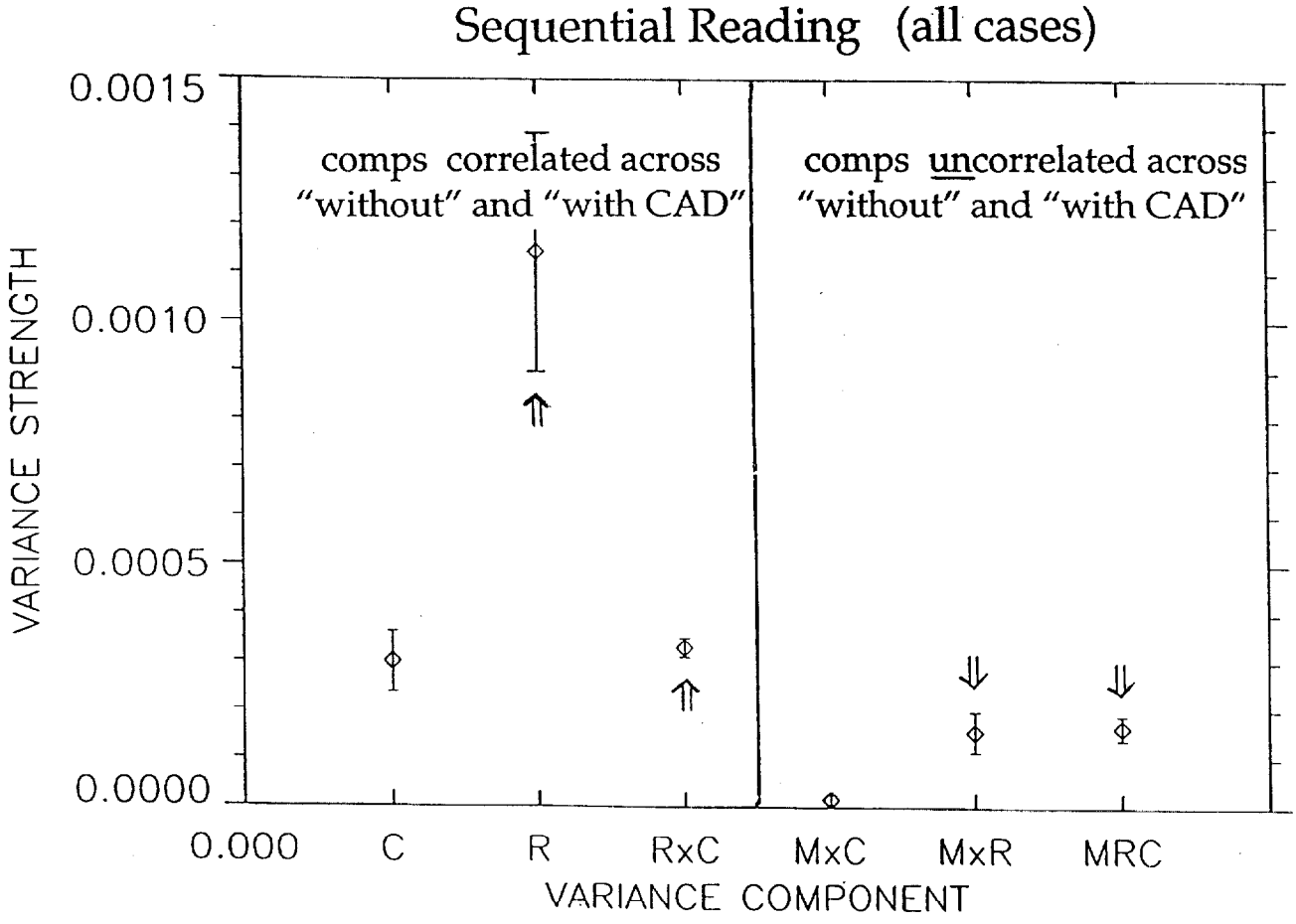
*Acad Radiol 7, 341-349 (May 2000)


Independent Reading (all cases)
0.0015
0.0010
0.0005
0.0000
VARIANCE STRENGTH
comps correlated across "without" and "with CAD"
comps uncorrelated across "without" and "with CAD"
0.000
C
R
RxC
MxC
MxR
MRC
VARIANCE COMPONENT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VARIANCE COMPONENT

ROC Areas
(& 90% C.I. on difference*, ΔA)
w/o computer assist => with computer assist

Independent Reading Condition

Task	LABMRMC Results	case/reader Boots
All cases (80 ca *vs* 160 non ca)	0.829 => 0.865 (0.016, 0.058)	0.827 => 0.864 (0.011, 0.066)
Smallest (9 – 14 mm ca *vs* 160 non ca)	0.798 => 0.848 (0.017, 0.084)	0.796 => 0.849 (0.012, 0.092)

Sequential Reading Condition

All cases (80 ca *vs* 160 non ca)	0.835 =>0.865 (0.019, 0.043)	0.835 => 0.864 (0.015, 0.047)
Smallest (9 – 14 mm ca *vs* 160 non ca)	0.800 => 0.848 (0.026, 0.068)	0.801 => 0.849 (0.025, 0.076)

*Left-hand entry is thus boundary
of 95% C.I. for ΔA > that value

Sensitivities and Specificities when "cut-off = 50%"
(& 90% C.I. on difference)
w/o computer assist => with computer assist

Independent Reading Condition

Task	Specificity*	Sensitivity
All cases (80 ca *vs* 160 non ca)	0.201 => 0.222 (-0.043, 0.077)	0.704 => 0.777 (0.002, 0.148)
Smallest (#=38) (9 – 14 mm ca *vs* 160 non ca)	0.200 => 0.222 (0.-0.037, 0.081)	0.641 => 0.743 (0.007, 0.207)

Sequential Reading Condition

All cases (80 ca *vs* 160 non ca)	0.197 => 0.222 (-0.003, 0.048)	0.721 => 0.777 (0.023, 0.093)
Smallest (9 – 14 mm ca *vs* 160 non ca)	0.198 => 0.222 (0.000, 0.049)	0.669 => 0.743 (0.033, 0.132)

*All C.I.s for difference in specificity contain 0.0
=>consistent with no change in specificity

SKIP DOWN TO

CONCLUSIONS

(Just doodling here for the moment)

Sequential Reading Condition with Computer Assist
leads to significant performance increase
for all lesions and for smallest lesions

Independent Reading Condition w Computer Assist
leads to slightly greater increase in mean performance
but less significance
for all lesions and for smallest lesions

[Significance might also be noted for – maybe ~~not~~ close call -- checking this:

LABMRMC: 0.840 ⇒ 0.870 (0.005, 0.055)
BOOTS: 0.837 ⇒ .872 (.003, 0.074)

intermediate lesions, Independent Mode (#ca = 25);

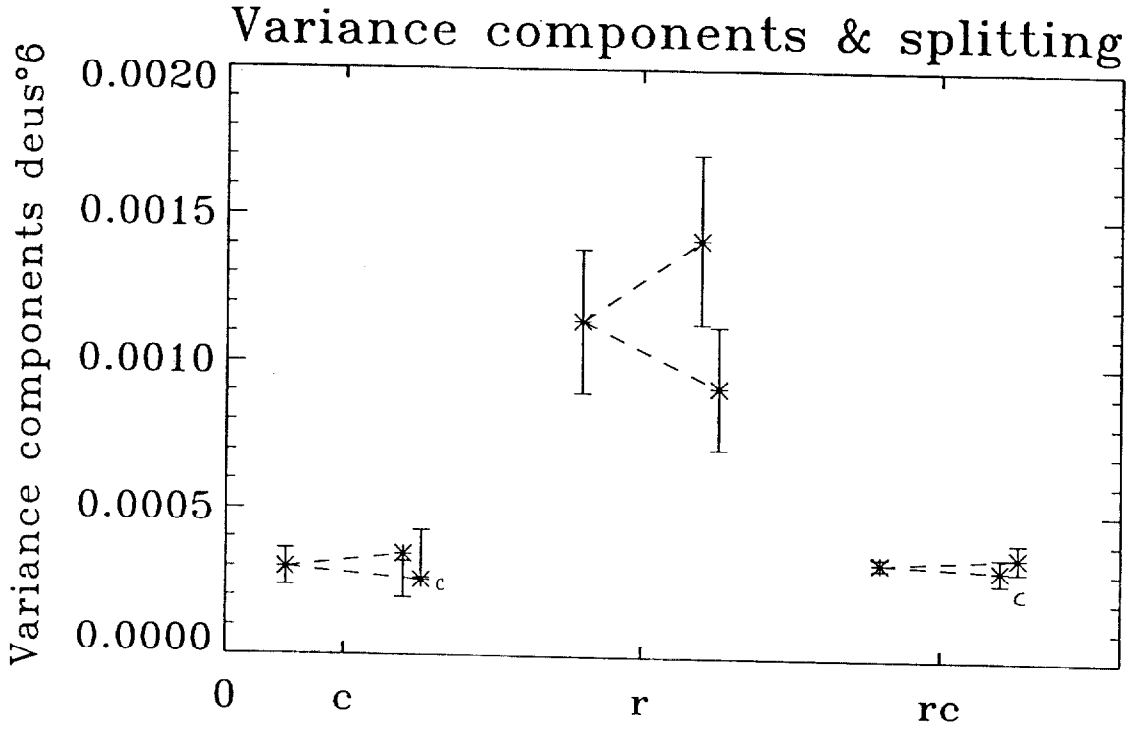
LABMRMC: 0.702 ⇒ 0.744 (0.010, 0.074)
BOOTS: 0.699 ⇒ 0.740 (0.006, 0.087)

"priors", sequential mode (#ca = 18)]

SMALL EFFECT

Another interesting point is that if you examine the "splitting" of the reader components before and after the computer assist, for all cases, you see a trend toward *more* reader variability *with* computer assist. I.e., there is a greater range of performance after the computer assist – suggesting that further training might enhance performance.

JUST FOR A SIDE ISSUE FOR OUR DISCUSSION.



SEQUENTIAL CONDITION

↑
UPPER BRANCH IS WITH COMPUTER

(NEVER SAW THINGS GO THIS WAY BEFORE!)