Statistical Literacy: Bayesian Significance

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Slides: 2026-Schield-ASA-slides.pdf

Paper: 2026-Schield-ASA.pdf

Statistical Significance (SS): Problems and Solutions

Fixed level percentage is misunderstood:

- 'important', arbitrary, confusion of the inverse.

Fixed level ignores important factors:

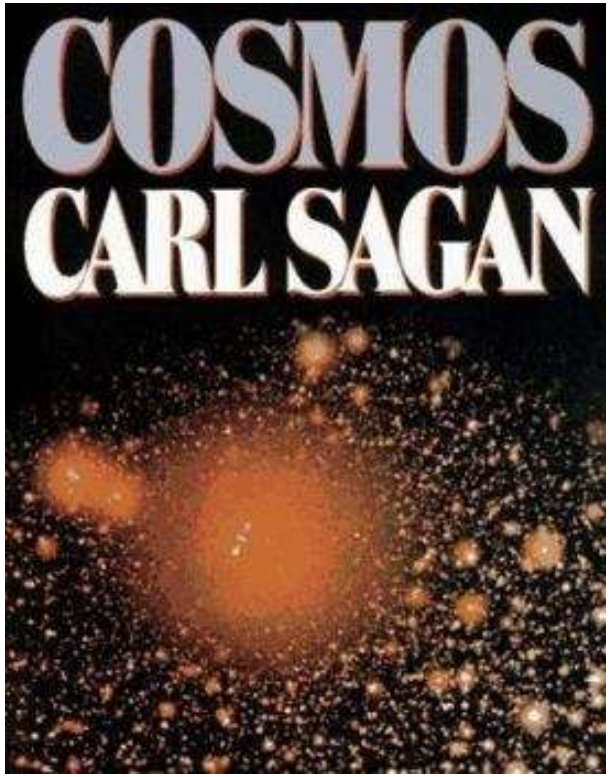
- Effect size, study design, research hypothesis

Two solutions:

- Stop using Stat. Signif. (Wasserstein et al, 2019)
- Use a lower value (Benjamin 2018)
- Attach labels to levels: weak, moderate, strong

Fixed p-values for Stat Sig violates ECREE

ECREE: *Extraordinary Claims Require Extraordinary Evidence.*



Propose a Simple Model for a variable p-value

- Introduce a new idea: *Bayesian Significance 95% confident that Research Hypothesis is true provided the p-value is below a certain value.*
- Derive the p-value for *Bayesian Significance*
- Can be taught without Algebra in 30 minutes
- Makes intuitive sense.
- Better than the existing alternatives.

Model Significance: Five Steps

1. *Start with a medical test: standard 2x2.*
2. *Use Simple test: S=Sensitivity=Specificity*
3. *Introduce Bayes Significance: PPV = 0.95*
4. *Introduce Research Hypothesis (RH) and P-value (PV) where PV = 1 - S.*
5. *Solve the maximum p-value for Bayes Significance as a function of base rate.*

Model Significance: 1) Medical Tests:

Medical test	DISEASED		DISEASED	
RESULT	No	Yes	No	Yes
Negative	Specificity	Type 2	True Neg	False Neg
Positive	Type 1	Sensitivity	False Pos	True Pos
Total (Col %)	100%	100%		
Row %	(1 - BR)	Base Rate		

Specificity = P(True Neg | No)

Sensitivity = P(True Pos | Yes)

SIMPLE Medical Test: 2) Sensitivity=Specificity

Medical test	DISEASED		
Result	No	Yes	Total
Negative	95	5	100
Positive	5	95	100
Total	100	100	200

50% are diseased; 95% confirmation accuracy

#3: PPV: Positive Predictive Value = P(Yes|Pos)

! If disease prevalence = 50% and Specificity = Sensitivity = 95%, then PPV = 95%.

SIMPLE Medical Test: 3) *Bayesian Significance*

Simple test	**DISEASED**		*Bayes Significant*	
RESULT	No	Yes	Total	PV
Negative	70,560	560	71,120	99%
Positive	1,440	27,440	28,880	95%
Total	72,000	28,000	100,000	28%

PPV=95%. *BaseRate=28%.* ***Simple:*** S=Sensitivity=Specificity=98%

!! If PPV = 95% and disease prevalence = 28%, then **S** must be 98% for Bayes Significance.

As BaseRate ↓, S must ↑ for Bayes Significance

4) Introduce p-value (PV) and Research Hypothesis

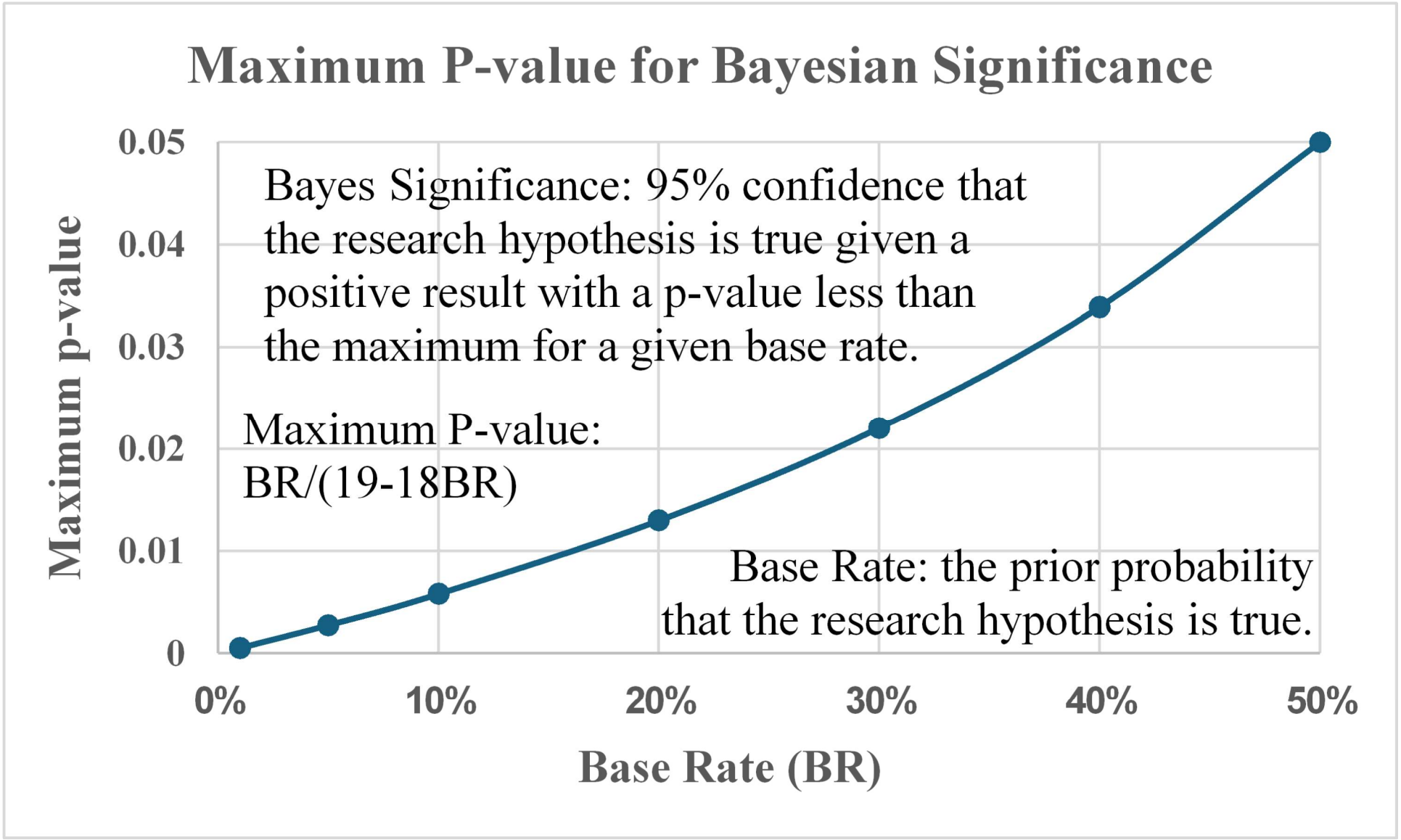
P-value = PV = 1 – S

Simple test	Research Hypothesis		*Bayes Significant*	
RESULT	FALSE	TRUE	Total	Row%
Negative	(1-BR)(1-PV)	BR*PV	Sum(Neg)	NPV
Positive	(1-BR)*PV	BR*(1-PV)	Sum(Pos)	***PPV***
Total	(1-BR)	BR	1	BR

PPV = 0.95 = BR*(1-PV) / [BR*(1-PV) + (1-BR)*PV]

Solve for maximum P-value (PV) for Bayes Significance as a function of the base rate (BR): chance RH is true.

Hypothesis Testing: 5) Bayesian Significance



Recommendations for Statistical Educators

1. Disallow using a fixed p-value for statistical significance: it violates Sagan's ECREE
2. Introduce Bayesian Significance as a featured topic in introductory statistics.
3. Provide studies using $p < 0.05$ where the truth of the research hypothesis is highly questionable.
4. Just as we say, "correlation is not causation", we should say, "the more disputable the research hypothesis, the smaller the p-value needed."

Recommendations for Journal Editors:

Editors of journals dealing with statistical significance should require *Bayesian significance*.

Editors should presume that every research hypothesis is very unlikely: Base rate = 10%, p-value < 0.005.

Authors must argue for a higher base rate to justify a higher p-value.

Social Benefit of Bayesian Significance

Students: Our students expect statistics to support the chance the research hypothesis is true. They can appreciate the value of Bayes Significance. Seeing how the p-value supports Bayesian Significance may help them see the value of studying statistics.

Quantitative Disciplines. Many of the statistical studies that can not be replicated involve the use of $p < 0.05$ when the research hypothesis is unlikely. Setting this standard may improve the quality of research in the social sciences and eliminate BS: Bad Statistics.

Statistical Educators have a Choice

1. *Continue teaching a fixed p-value for statistical significance* – though it violates Sagan's ECREE: extraordinary claims require extraordinary evidence.
2. *Stop teaching statistical significance in accordance with the 2019 ASA recommendation* – even though statistical significance is one of the greatest contributions of statistics to human knowledge.
3. *Support Bayesian significance and a variable p-value* based on the plausibility of the research hypothesis.

Bibliography

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JSM Birds of a Feather: Discuss Bayes Significance

Agenda:_https://docs.google.com/document/d/1CiZCqaNCKAJomHHpF4F2HwoPIA1lhM5_xAXVHJo_-Yk/edit?tab=t.0

Discuss Bayesian Significance.

- Wednesday (8/5/2026) 4:00-5:00 pm EDT.
  In person: meet at StatEd booth.

- Zoom Thurs (8/13/2026) 4:00-5:00 pm EDT
  Zoom: https:/augsburg.zoom.us/j/5404394478?pwd=cy94UlZUTEV5VnFZV1pKRU44Vk1vUT09

Concerns: Birds of a Feather

1. How do we get a p-value from the Research Hypothesis? Where is the null hypothesis?
2. What is a 'positive result' for a research hypothesis?
3. Can we justify converting continuous distributions into binary categories? See Schield (1996).
4. Can we justify setting Type2 error rate = Type1?
5. Should we say "95% confidence that the Research hypothesis (or something closely related) is true."