Breaking Out of Tradition: Statistical Innovation in Psychological Science

S.N. MacEachern[1] & T. Van Zandt[2]

[1]Department of Statistics, The Ohio State University

[2]Department of Psychology, The Ohio State University

Friday, 16 November 2018

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Outline

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Conclusions

- A black-box approach is guaranteed to produce poor-quality conclusions.
- Exploratory data analysis is necessary for good modeling and should be encouraged.
- Behavioral data are messy, and hierarchical models are the best way to explain individual differences.

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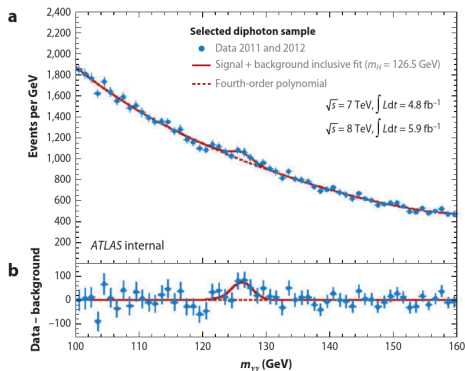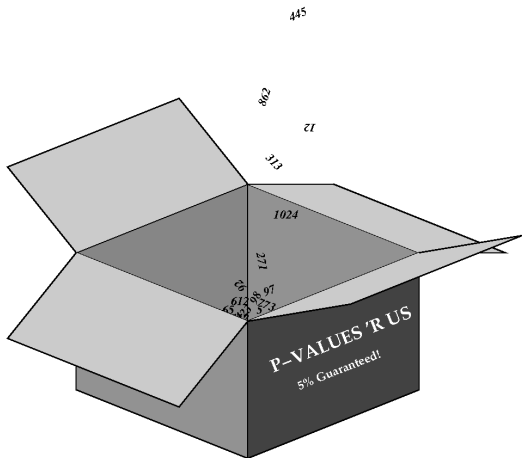
Fisher was a Geneticist

Figure 1

A subset of the 2011 and 2012 ATLAS event counts. (*a*) The observed event counts in the $\gamma\gamma$ decay channel in each invariant mass bin. (*b*) Residuals from the fitted background model. The excess counts with invariant mass near 125 GeV are apparent. The background models are disused in Section 3, and the source model is based on the Standard Model with Higgs mass (m_H) of 126.5 GeV. The quantity $\sqrt{s}$ is the energy of the collider, and $\int L dt$ is the volume of data at each energy used in the plot. Copyright CERN.

Outline

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The Black-Box Approach

A Recognition Memory Study: Lab A

Ten participants studied lists of words in two conditions (hard and easy). They were then tested with 20 words, 10 old and 10 new.

	Condition	
	Hard	Easy
Mean d'	2.05 ± 0.35	2.58 ± 0.26
$t(9) = 1.6658, \ p > 0.05$		

Pitt & Van Zandt, in preparation

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A Recognition Memory Study: Lab B

Ten participants studied lists of words in two conditions (hard and easy). They were then tested with 20 words, 10 old and 10 new.

	Condition	
	Hard	Easy
Mean d'	2.05 ± 0.35	2.64 ± 0.25
$t(9) = 1.8855$, $p < 0.05$		

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A closer look

	Hard, Labs A & B			Easy, Lab A			Easy, Lab B		
	Hits	FAs	d'	Hits	FAs	d'	Hits	FAs	d'
1	7	5	0.47	7	2	1.22	7	2	1.22
2	8	2	1.50	10	0	3.38	10	0	3.38
3	9	1	2.19	10	2	2.44	10	2	2.44
4	10	2	2.44	8	2	1.50	8	2	1.50
5	9	1	2.19	9	1	2.19	9	0	2.79
6	10	0	3.38	10	1	2.79	10	1	2.79
7	5	5	0.00	7	0	2.16	7	0	2.16
8	10	0	3.38	10	0	3.38	10	0	3.38
9	9	0	2.79	10	0	3.38	10	0	3.38
10	9	1	2.19	10	0	3.38	10	0	3.38
	Mean d'		2.05			2.58			2.64

Snodgrass & Corwin (1988) correction applied.

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5	9	1	2.19	9	1	2.19	9	0	2.79
6	10	0	3.38	10	1	2.79	10	1	2.79
7	5	5	0.00	7	0	2.16	7	0	2.16
8	10	0	3.38	10	0	3.38	10	0	3.38
9	9	0	2.79	10	0	3.38	10	0	3.38
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	Mean d'		2.05			2.58			2.64

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Problems

- No thought given to:
    - models that provide process/theoretical explanations;
    - what constitutes qualitative (vs. quantitative) differences over conditions;
    - whether effects are interesting.
    - the assumptions that are brought into the analysis.
- Any threshold/"bright line" approach to determining what is true or false is ludicrous.

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Box (1976)
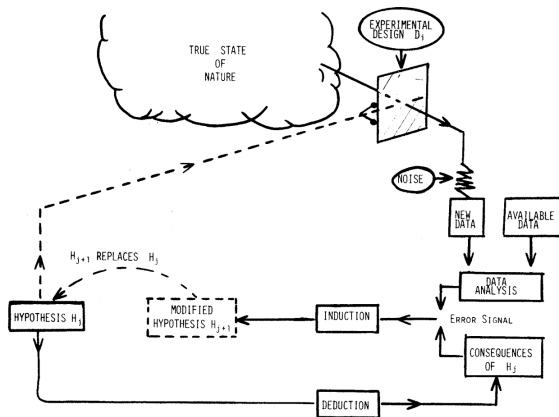
a The experimental design is here shown as a movable window looking onto the true state of nature. Its positioning at each stage is motivated by current beliefs, hopes, and fears.
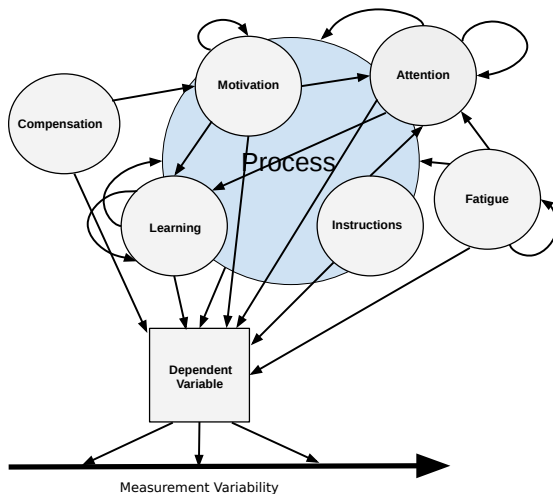
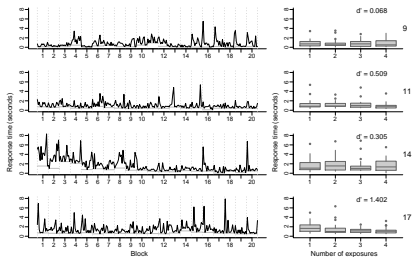# Outline

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Thoughtful Statistics

- Build models that are based on theory;
- Make use of exploratory data analysis;
- Draw conservative conclusions.
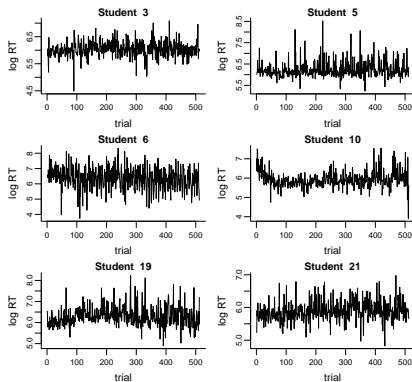- Acknowledge that data are messy;

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Behavioral Data

Individual Differences

Kim et al., 2017

Kunkel et al., in press

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Preregistration and Online Supplements

Transparency!

- Preregistration of studies is not enough: planned/preregistered analyses *should* change after the researcher examines the data.
- All raw data and code should be included as supplements at publication.

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Things We Should See More Of

- Cross validation
- Model averaging
- Robust methods/Bayesian sensitivity analysis
- Nonparametric Bayesian methods

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Conclusions

- A black-box approach will never be able to provide the insight we are looking for.
- Exploratory data analysis is necessary for good modeling and should be encouraged.
- Behavioral data are messy, and hierarchical models are the best way to explain individual differences.

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Thank you.

A Final Word from Box (1976)

Since all models are wrong the scientist must be alert to what is importantly wrong. It is inappropriate to be concerned about mice when there are tigers abroad.

Tightening Criteria ($p < .005$)

Benjamin et al. (2017)