

THEORIES AS ORDINAL CONSTRAINT

A BAYES FACTOR APPROACH

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TESTING THEORIES USING ORDINAL CONSTRAINT

- Is there a *true* effect?



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- Example: Inhibition ($\rightarrow\rightarrow\leftarrow\rightarrow\rightarrow$ vs. $\leftarrow\leftarrow\leftarrow\leftarrow\leftarrow$)



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- Is there a *true* effect?
- Example: Inhibition ($\rightarrow\rightarrow\leftarrow\rightarrow\rightarrow$ vs. $\leftarrow\leftarrow\leftarrow\leftarrow\leftarrow$)
- Is the *true* effect in the expected direction?

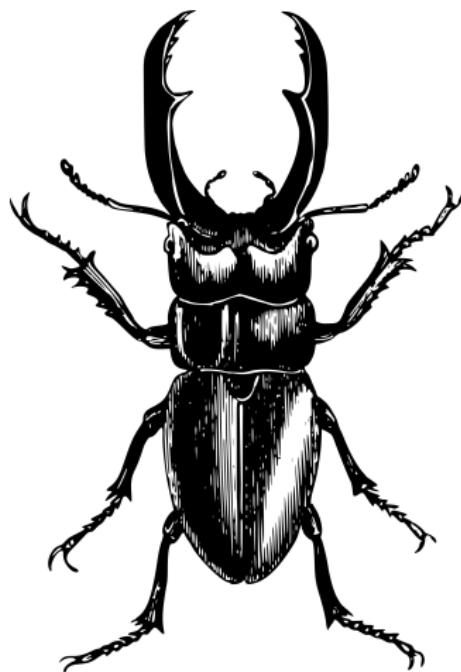


TESTING THEORIES USING ORDINAL CONSTRAINT

- Is there a *true* effect?
- Example: Inhibition ($\rightarrow\rightarrow\leftarrow\rightarrow\rightarrow$ vs. $\leftarrow\leftarrow\leftarrow\leftarrow\leftarrow$)
- Is the *true* effect in the expected direction?
- **Idea: Stating theory as multiple, simultaneous ordinal constraint**



A PSYCHOLOGIST'S FAVORITE DESIGN WITH UGLY BUGS



A PSYCHOLOGIST'S FAVORITE DESIGN

RYAN, WILDE, & CRIST (2013)

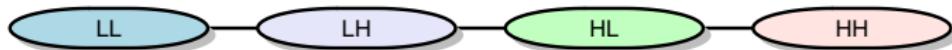
		Disgust	
		Low	High
Fear	Low	Low/Low	Low/High
	High	High/Low	High/High

"How willing are you to kill this bug?"



SYSTEMS OF ORDERS WITH BUGS

M_0 : Null



M_1 : Consistent +

M_2 : + Equality

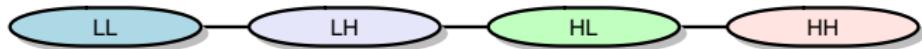
M_3 : Fear Only

M_4 : Disgust Only

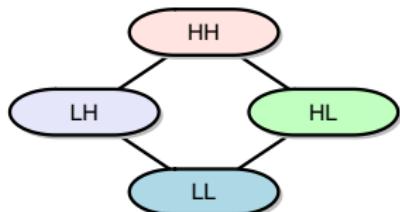
M_5 : Unconstrained

SYSTEMS OF ORDERS WITH BUGS

M_0 : Null



M_1 : Consistent +



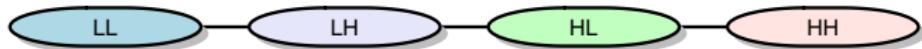
M_2 : + Equality

M_3 : Fear Only

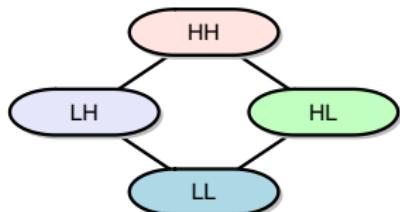
M_4 : Disgust Only

SYSTEMS OF ORDERS WITH BUGS

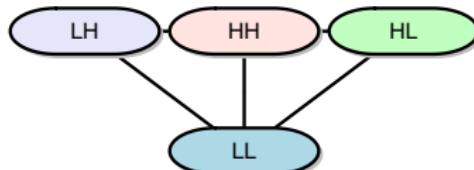
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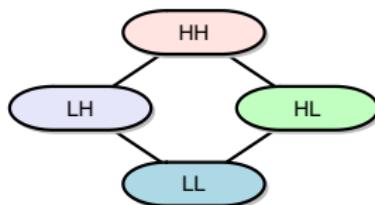
M_5 : Unconstrained

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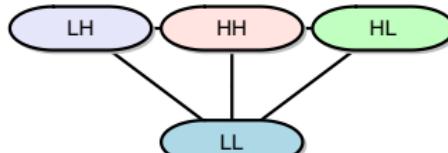
M_0 : Null



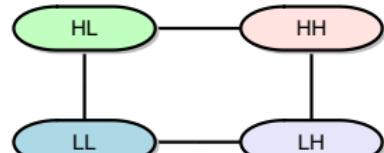
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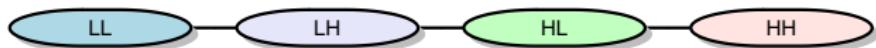


M_4 : Disgust Only

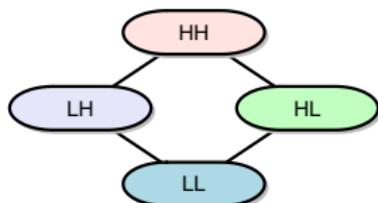
M_5 : Unconstrained

SYSTEMS OF ORDERS WITH BUGS

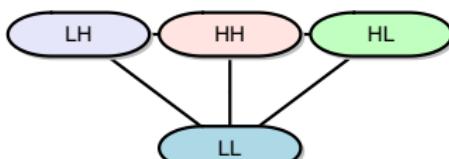
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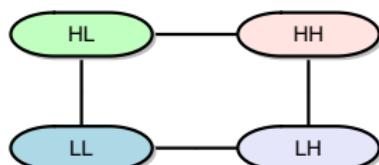
M_1 : Consistent +



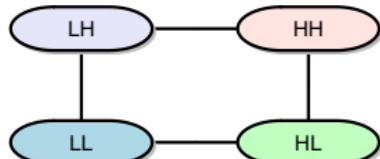
M_2 : + Equality



M_3 : Fear Only



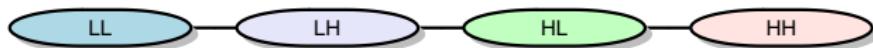
M_4 : Disgust Only



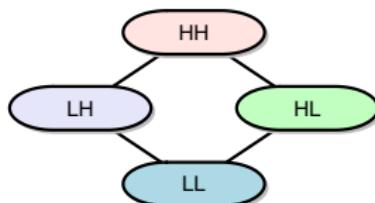
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SYSTEMS OF ORDERS WITH BUGS

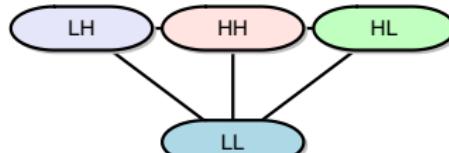
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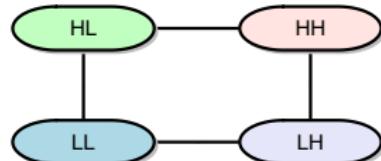
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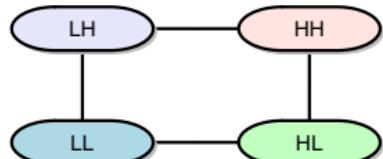
M_2 : + Equality



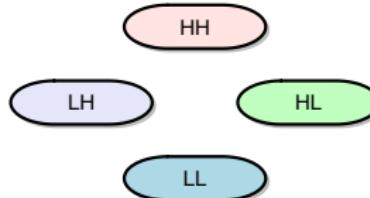
M_3 : Fear Only



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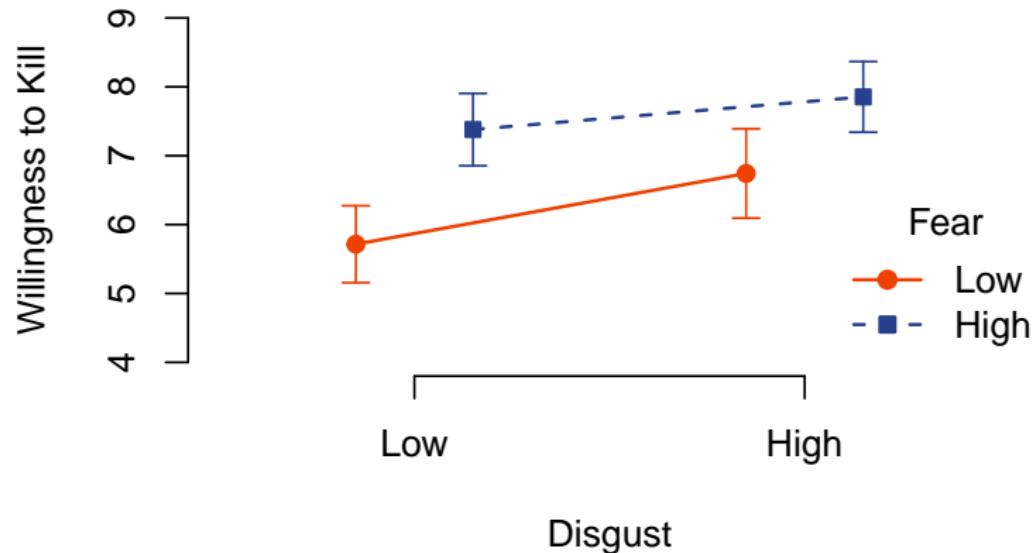


M_5 : Unconstrained



SYSTEMS OF ORDER ANALYSIS WITH BUGS

DATA



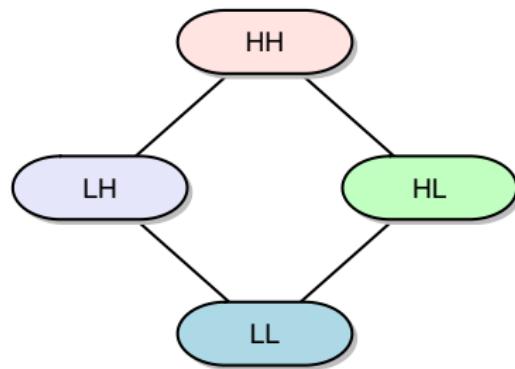
SYSTEMS OF ORDER ANALYSIS WITH BUGS

RESULTS

- Preferred model: **Consistent positive** model (M_1)
- Preferred 3.08-to-1 over the **positive equality** model (M_2)
- Preferred 3.76-to-1 over the **fear only** model (M_3)
- Preferred 5.30-to-1 over the **unconstrained model** (M_5)
- Preferred 11662-to-1 over the **disgust only** model (M_4)
- Preferred 52582-to-1 over the **null** model (M_0)

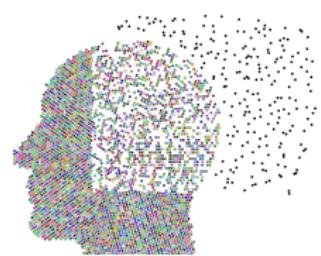
PREFERRED MODEL

M_1 : Consistent +



TAKE-AWAY FOR THE PRAGMATIC PSYCHOLOGIST

- You know a lot about ordinal predictions from theory!



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TAKE-AWAY FOR THE PRAGMATIC PSYCHOLOGIST

- You know a lot about ordinal predictions from theory!
- Bayesian model comparison gives an accessible framework to test *your* predictions
- Bayesian analysis means you have to add value even after running your analysis
- Are you convinced by a Bayes factor of 3-to-1?



A STEP FURTHER: ORDINAL CONSTRAINT ACROSS PEOPLE



A STEP FURTHER

ORDINAL CONSTRAINT ACROSS PEOPLE

- Stimulus strength: Does everyone truly detect bright lights faster than dim ones? (Most likely)

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ORDINAL CONSTRAINT ACROSS PEOPLE

- Stimulus strength: Does everyone truly detect bright lights faster than dim ones? (Most likely)
- Handedness: Does everyone have a true right handed advantage? (Clearly no)
- **Symbolic distance: Does everyone truly represent numbers as analog quantities? (IDK)**

SYMBOLIC DISTANCE

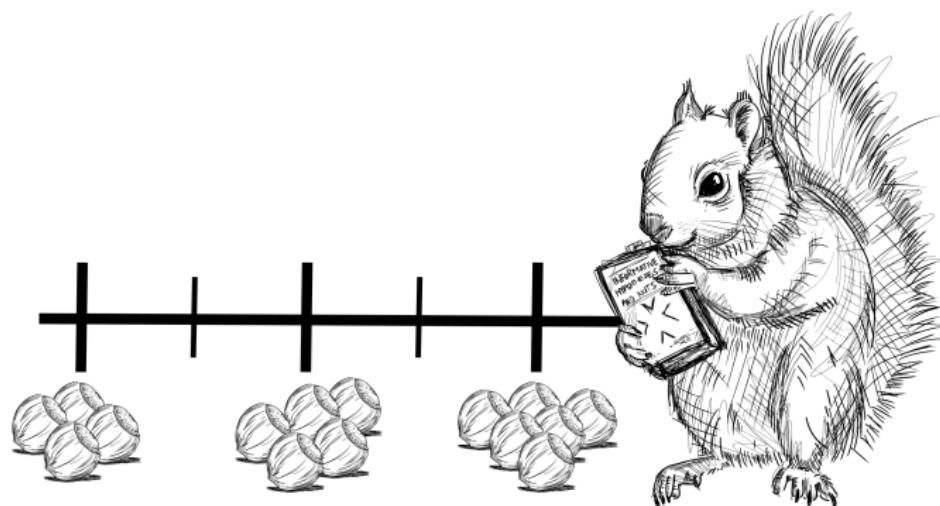
HOW DO WE REPRESENT NUMBERS INTERNALLY?



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THEORETICAL POSITIONS:

- ① Everyones uses analog representation.



HOW DO WE REPRESENT NUMBERS INTERNALLY?

THEORETICAL POSITIONS:

- ① Everyones uses analog representation.
- ② Everyone uses propositional representation.

$$\begin{array}{ccc} \text{nuts} & < & \text{nuts} \\ & & = \text{true} \end{array}$$



HOW DO WE REPRESENT NUMBERS INTERNALLY?

THEORETICAL POSITIONS:

- ① Everyones uses analog representation.
- ② Everyone uses propositional representation.
- ③ Everyone uses priming + spreading activation.



HOW DO WE REPRESENT NUMBERS INTERNALLY?

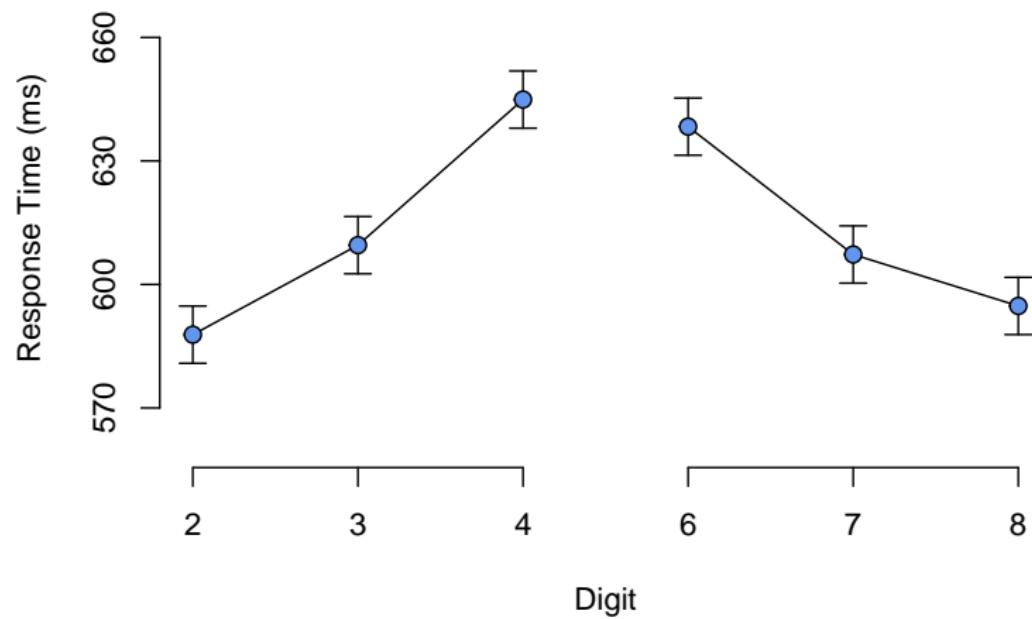
THEORETICAL POSITIONS:

- ① Everyones uses analog representation.
- ② Everyone uses propositional representation.
- ③ Everyone uses priming + spreading activation.
- ④ None of the above.



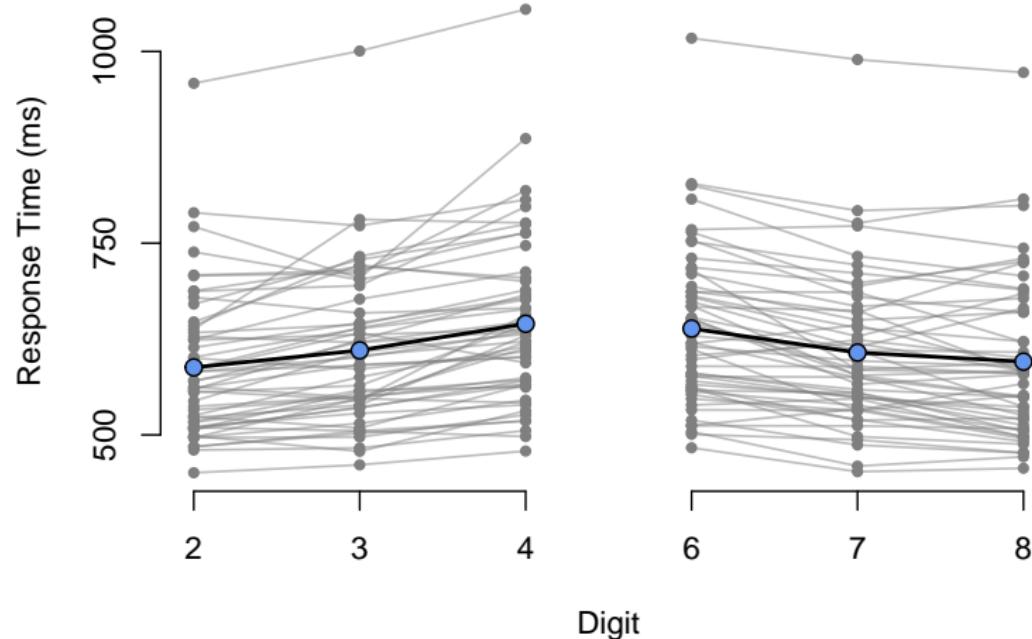
RESULTS FOR “DOES EVERYONE” ANALYSIS

ROUDER, LU, SPECKMAN, SUN, & JIANG (2005)



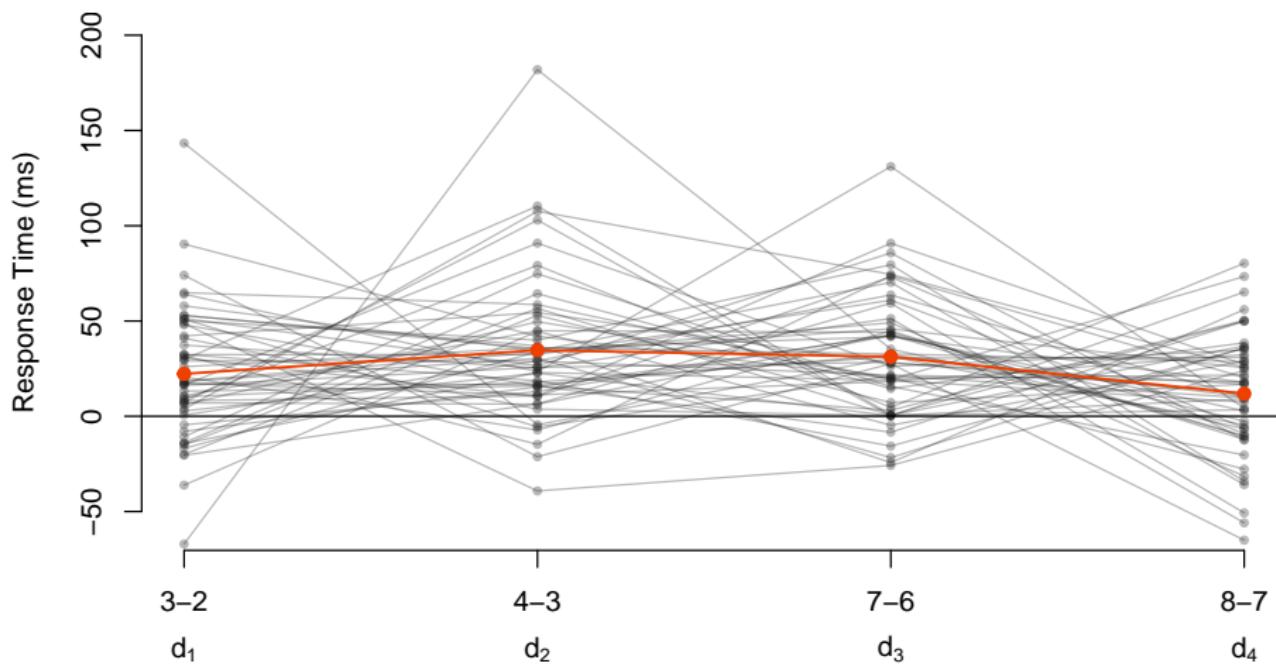
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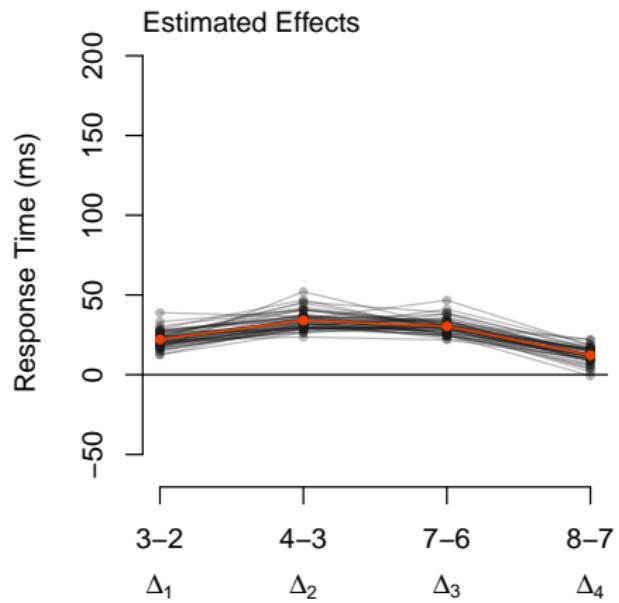
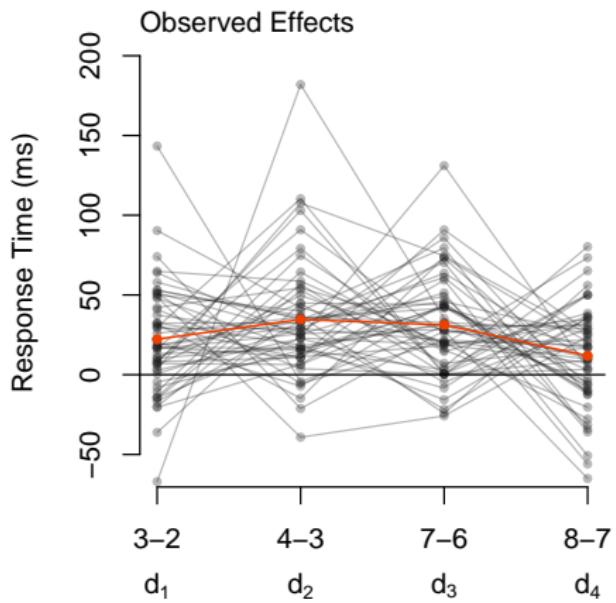


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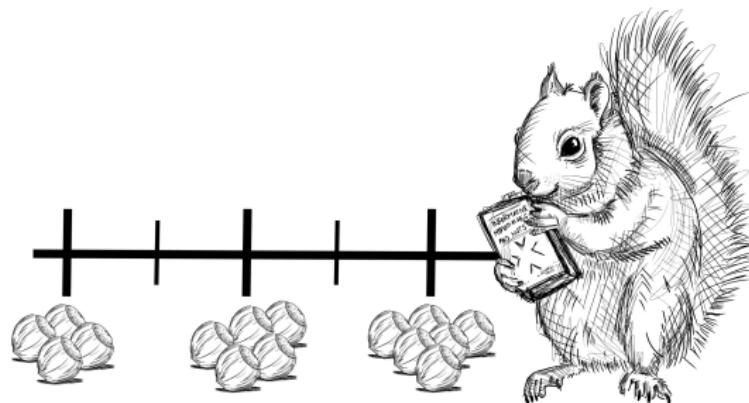


RESULTS FOR “DOES EVERYONE” ANALYSIS



RESULTS FOR “DOES EVERYONE” ANALYSIS

- Preferred model: **Analog representation** model
- Preferred 11.56-to-1 over the **None of the above** model
- Preferred 3×10^{55} -to-1 over the **Propositional representation** model
- Bayes factor for **Priming + spreading activation** model cannot be estimated



TAKE-AWAY FOR THE PRAGMATIC PSYCHOLOGIST

- ① Theoretical ordinal predictions may account for everyone
- ② “Everyone Does” models are parsimonious descriptions of common mechanisms
- ③ Bayesian analysis is the perfect tool for assessing multiple simultaneous ordinal predictions



FURTHER REOURCES FOR THE PRAGMATIC PSYCHOLOGIST

- Accessible book to get started with systems of orders: Hoijtink (2012)
- Software packages: `bain` or `BayesFactor` for R users
- “Does everyone” analysis: Haaf & Rouder (2017)
- **Presentation and all code is available at:**
tinyurl.com/OrdinalConstraint

THANK YOU



Fayette Klaassen
(Utrecht University)

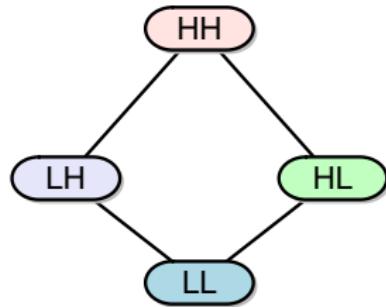


Jeff Rouder
(University of California - Irvine)

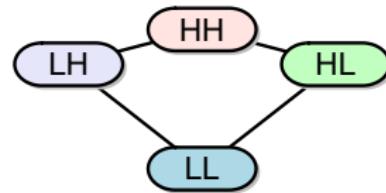
ADDITIONAL SLIDES

PREFERRED MODEL

M_1 : Consistent +



M_1 : Consistent +



REFERENCES

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- Hoijtink, H. (2012). *Informative Hypotheses. Theory and Practice for Behavioral and Social Scientists*. Boca Raton: Chapman & Hall/CRC.
- Rouder, J. N., Lu, J., Speckman, P. L., Sun, D., & Jiang, Y. (2005). A hierarchical model for estimating response time distributions. *Psychonomic Bulletin and Review*, 12, 195–223.
- Rouder, J. N., Morey, R. D., Speckman, P. L., & Province, J. M. (2012). Default Bayes factors for ANOVA designs. *Journal of Mathematical Psychology*, 56, 356–374. Retrieved from <http://dx.doi.org/10.1016/j.jmp.2012.08.001>
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