Type M error in practice: A case study

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1. Power is quite low in reading research
2. Low power leads to exaggerated estimates
3. Published claims will not be replicable
4. We demonstrate this with real data

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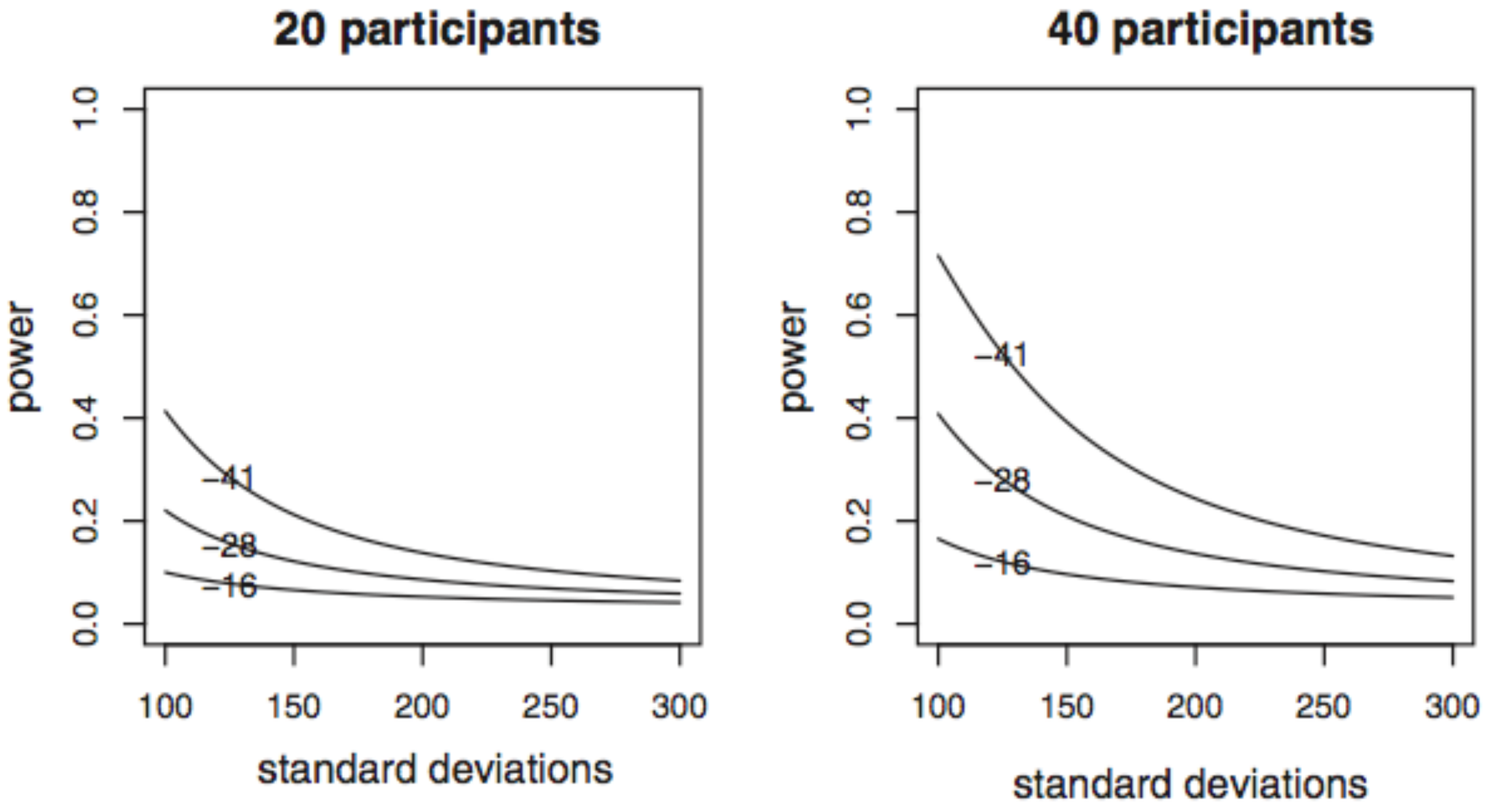
Research area: Reading processes in cognitive psychology

The Marketer: Alchemist, Magician, Sorcerer and Medicine Man

Is marketing an art or a science? Perhaps marketing is more like sorcery. Think of a sorcerer collecting ingredients from different sources and mixing them into a potion, accompanied with the magical effect of a flash of light and the illusion to follow. To some extent this fits with Cullitan's vision of a marketer as a 'mixer of ingredients'. Of course sorcerers are more mythical than real, but if we stay with this myth it may help to dispel some of the myths surrounding 'marketing'.

Though mythical, sorcerers were far from perfect. Not all their potions and spells succeeded. When they tried to cure diseases, the patient often died through severe poisoning -- and the fate of the sorcerer was anyone's guess. Perhaps the same could be said of alchemists. Alchemy was the medieval dream of using a 'philosopher's

Power is generally quite low in reading research



Jäger, Engelmann & Vasishth, 2017

We demonstrate Type M error in published data

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Expectation and locality effects in German verb-final structures

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Four replication attempts

- Two self-paced reading studies, two eye tracking
- Prospective power for Levy and Keller experiments:

Effect (ms)	Power (percentage)
30	11
50	28
80	51

[Full details in paper: bit.ly/TypeMError]

Hierarchical linear models in Stan

$$\log rt = \underbrace{X\beta}_{\text{fixed effects}} + \underbrace{Z_u b_u}_{\text{subjects random effects}} + \underbrace{Z_w b_w}_{\text{items random effects}} + \varepsilon$$

Priors:

$$\beta_0 \sim Normal(0,10)$$

$$\beta_{1,2,3} \sim Normal(0,1)$$

$$\sigma \sim Normal_+(0,1)$$

$$\rho \sim LKJ(\nu = 2)$$

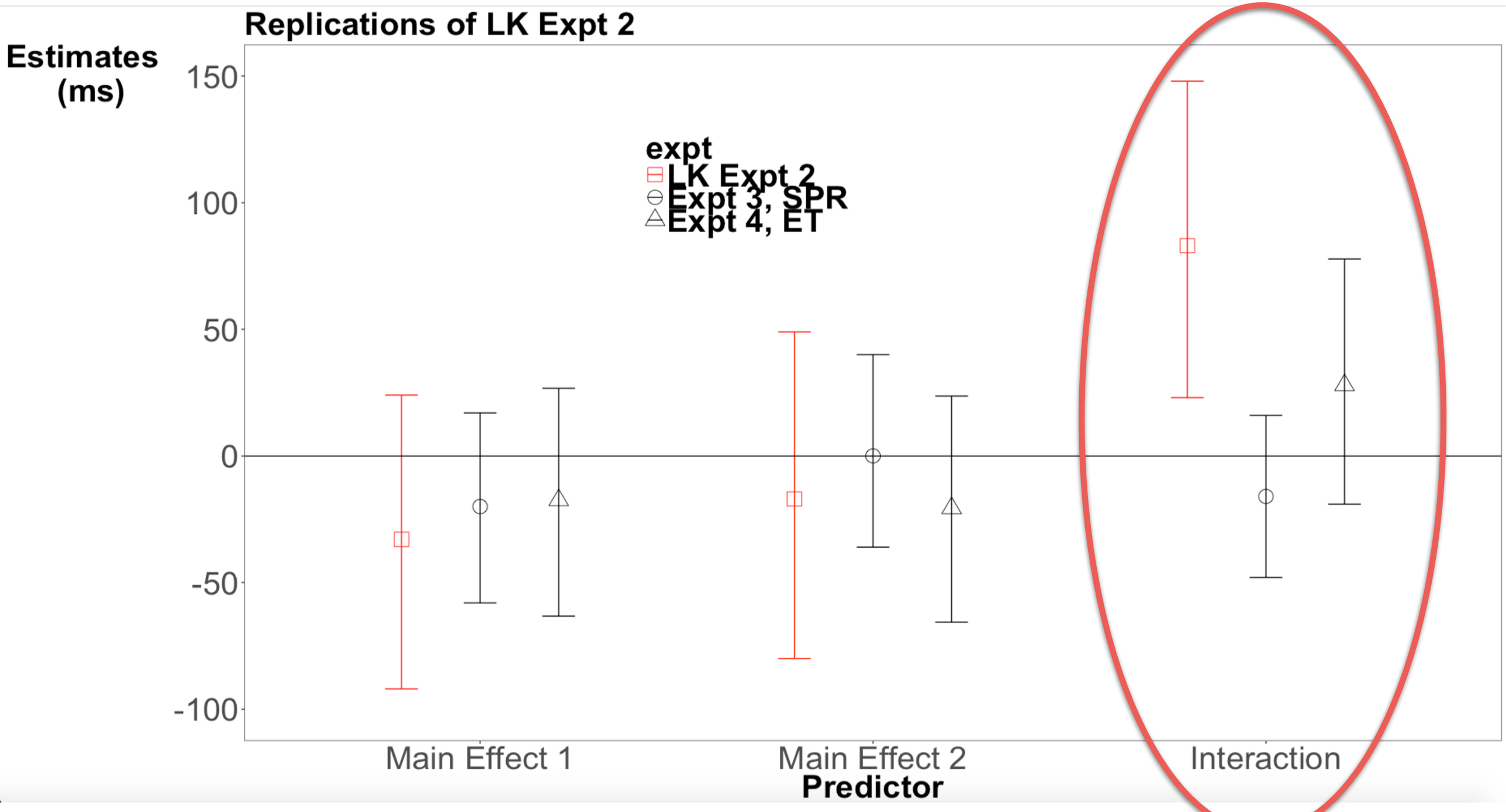
$$b_u \sim MVN_4(\mathbf{0}, \Sigma_u)$$

$$b_w \sim MVN_4(\mathbf{0}, \Sigma_w)$$

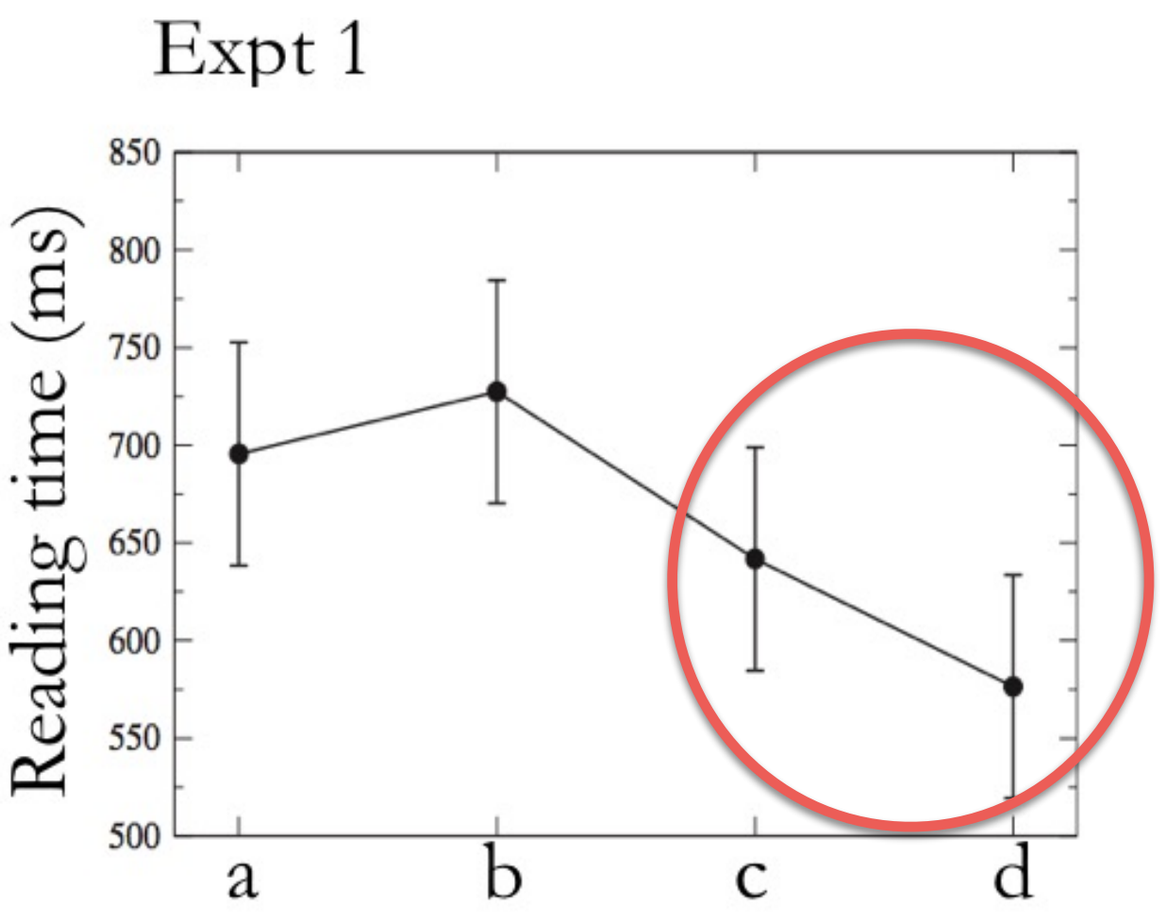
$$\varepsilon \sim Normal(0,\sigma)$$

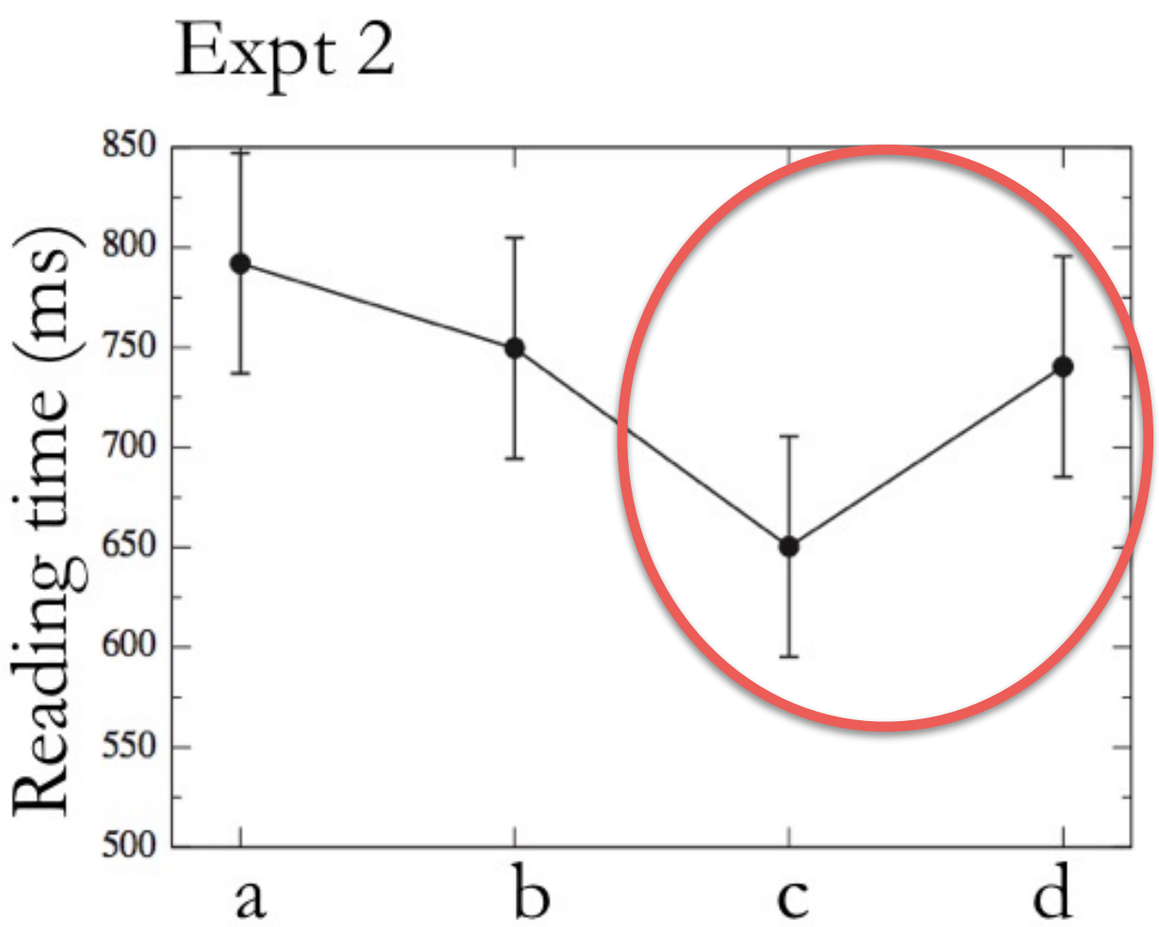
Levy & Keller's Expt 1 replication attempts

Levy & Keller's Expt 2 replication attempts



Levy & Keller 2013 claimed an interaction across the two experiments but never checked it statistically

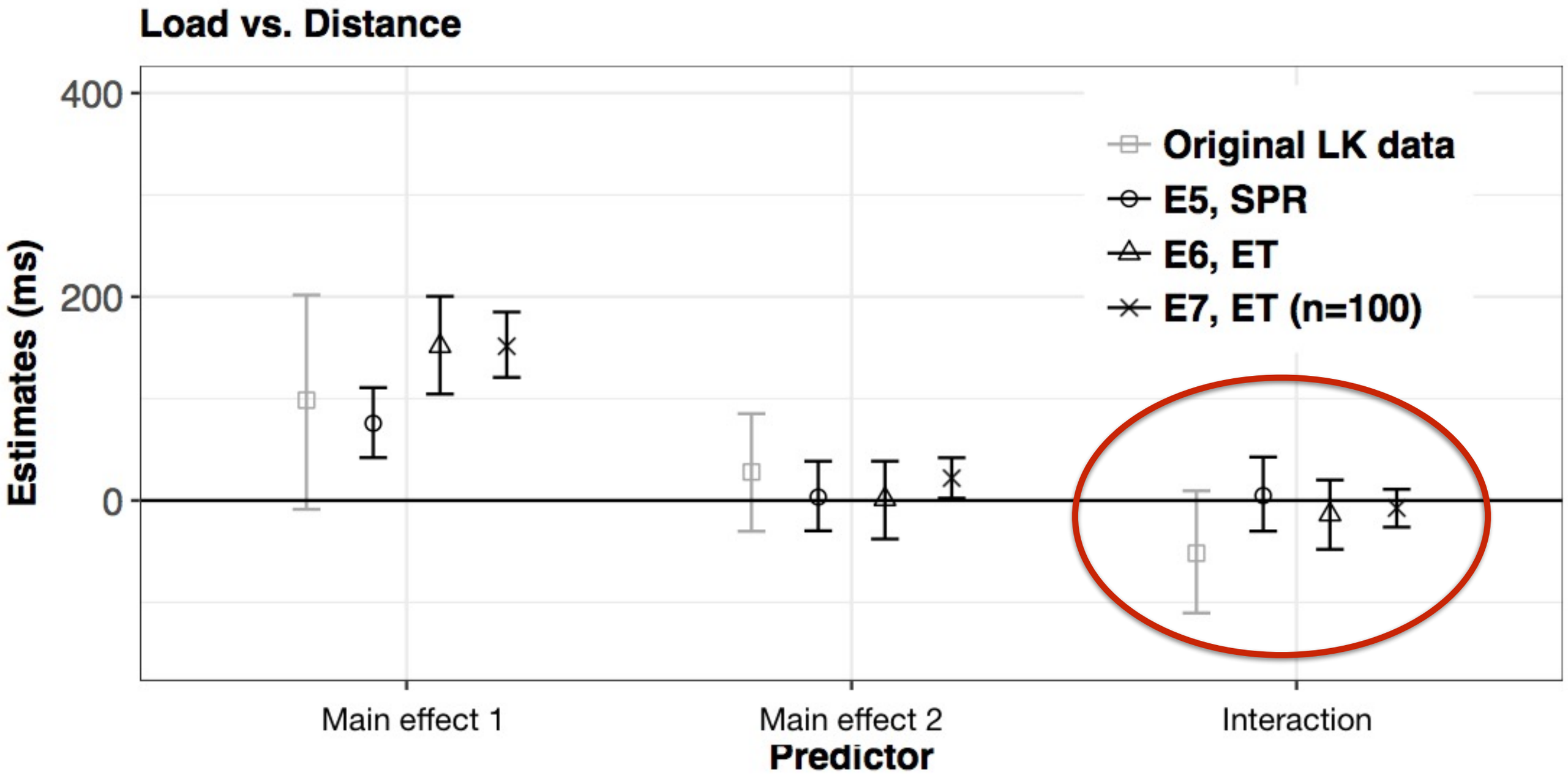




Three replication attempts of the claimed interaction

- Expt 5 (SPR): 28 participants, 24 items
- Expt 6 (ET): 28 participants, 24 items
- Expt 7 (ET): 100 participants, 24 items

Three replication attempts of the claimed interaction



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Concluding remarks

1. Expts with 268 subjects show not a single effect
2. The published effects are Type M errors
3. Many researchers still don't understand this point

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Concluding remarks

1. Move focus away from significance
2. Focus instead on estimation
3. Run higher-precision studies
4. Pre-register experiments
5. Conduct direct replications

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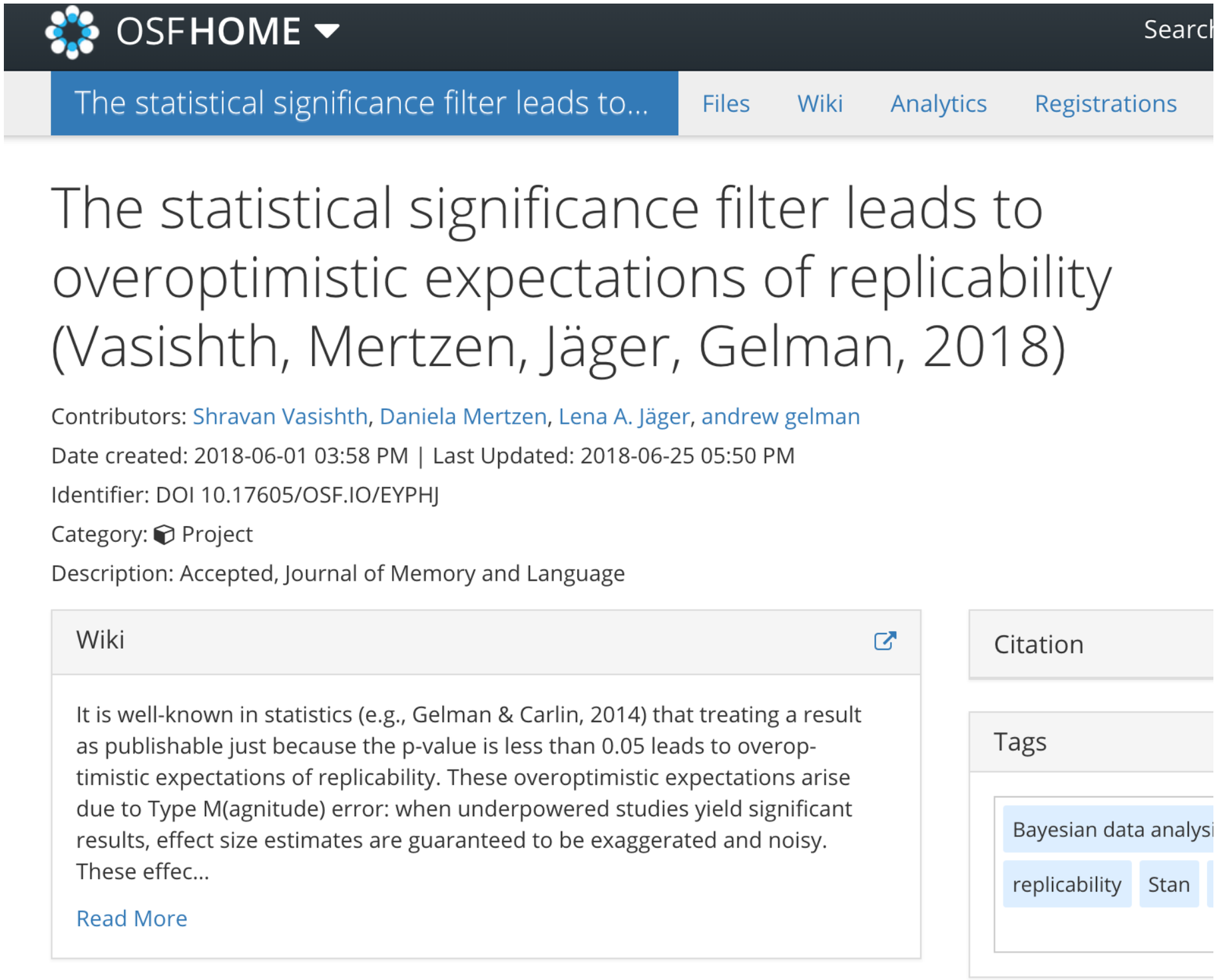

bit.ly/TypeMError