The Importance of Replication in Psycholinguistics

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1. Motivation

Failure to replicate published work

- Paape & Vasishth (2016): local coherence in German; self-paced reading (SPR), N = 40
- Husain, Vasishth, & Srinivasan (2014): expectation vs locality effect in Hindi; SPR, N = 60

3. Investigating Replicability

Six replication attempts of

Levy & Keller (2013): locality & anti- locality effects in German, eye-tracking, Experiments E1 and E2 N = 28 each

Why replicate Levy & Keller (2013)?

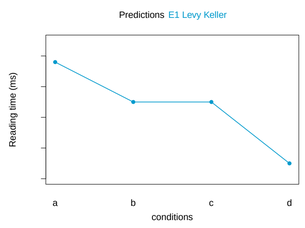
- typical participant sample size
- **theoretically highly plausible results**
  - support surprisal
    e.g. Hale (2001), Levy (2008)
  - support memory-based theories
    e.g. Lewis & Vasishth (2005)
  - existing empirical evidence
    - anti-locality effect
      e.g. Linzen & F. Jaeger (2015)
    - locality effect
      e.g. Bartek et al. (2011)

- Results E1: **anti-locality** effect (cond. d < c)
- Results E2: **locality** effect (d > c) → locality outweighs anti-locality when syntactic complexity is high

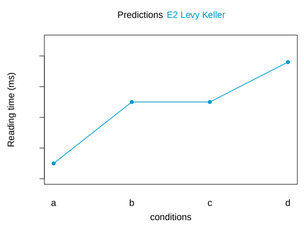
Seemingly robust results
$\Longrightarrow$ **effect should be replicable**

5. Levy & Keller (2013) Predictions

Surprisal theory
(anti-locality)
a > b; c > d



Memory accounts
(locality)
a < b; c < d



7. Conclusion

Replication failure:
Even seemingly robust results should be scrutinized

Low sample size
$\Longrightarrow$ low statistical power
$\Longrightarrow$ low probability of obtaining accurate estimates of true parameters (Type M error)

- **Prior to running an experiment compute sample size based on power calculations**
- **Replicate the effect to establish robustness** (see Nicenboim et al. (under revision), Safavi et al., 2016)

8. Future directions

We are currently planning a relatively high power large scale replication attempt of our eye-tracking study E6 (cond. c and d of the original E1 and E2 by Levy & Keller, 2013)

2. The Problem

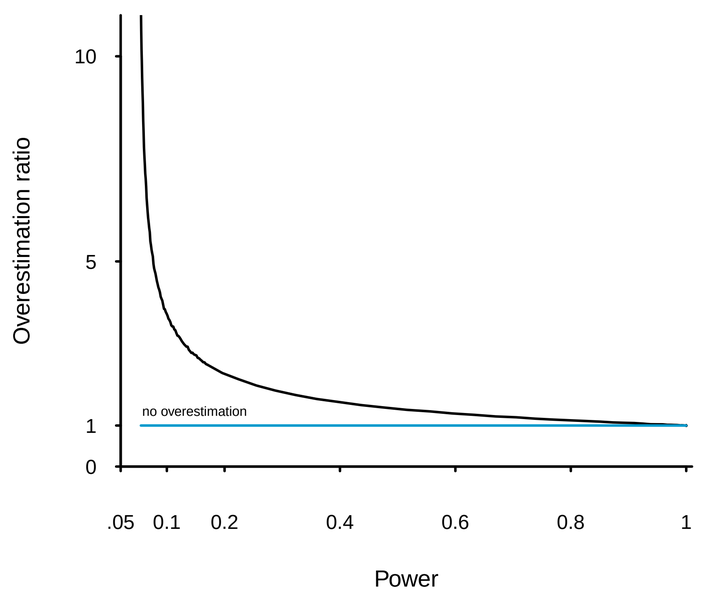
Low power due to small sample sizes (Gelman & Carlin, 2014) leads to:

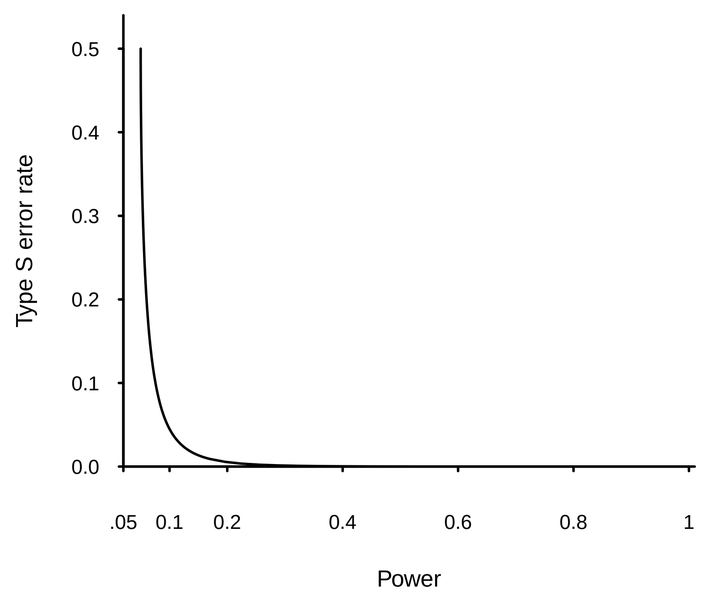
(i) high proportion of **null results**
If power is $\leq$ 20% (not uncommon in psycholinguistic studies) $\Longrightarrow$ **probability of finding a true effect only 20% or less**
For example, in L.A. Jäger et al., 2017 (Appendix B): effects (range: -16 to -33 ms, sd = 150 ms, N = 40, SPR studies) had power estimates ranging from 10% to 30%

If the estimated effect *is* statistically significant given that the effect is not 0, under repeated sampling, low power leads to:

(ii) Type M (= *magnitude*) error, i.e. an **overestimation** of the effect
(iii) Type S (= *sign*) error, i.e. effect in the **wrong direction**

Plots adapted from Gelman & Carlin (2014)





4. Design & Materials

2 × 2 fully-crossed factorial design
- Factor 1: Position of dative NP (**NP**) (main- vs subordinate clause)
- Factor 2: Position of PP adjunct (**PP**) (main- vs subordinate clause)

E1: target construction in main clause
E2: same construction embedded in relative clause → higher syntactic complexity
Critical region: **matrix clause verb** (**versteckt**, below) referring back to subject (Hans, below)

a. PP in subordinate clause, dative NP in subordinate clause
Nachdem der Lehrer [**PP** zur Ahnd.] [**NP** dem Sohn] ..., hat Hans ... den Fußball **versteckt**, ...
After the teacher [**PP** *as payback*] [**NP** *the son*] ..., *has Hans* ... *the football hid*, ...

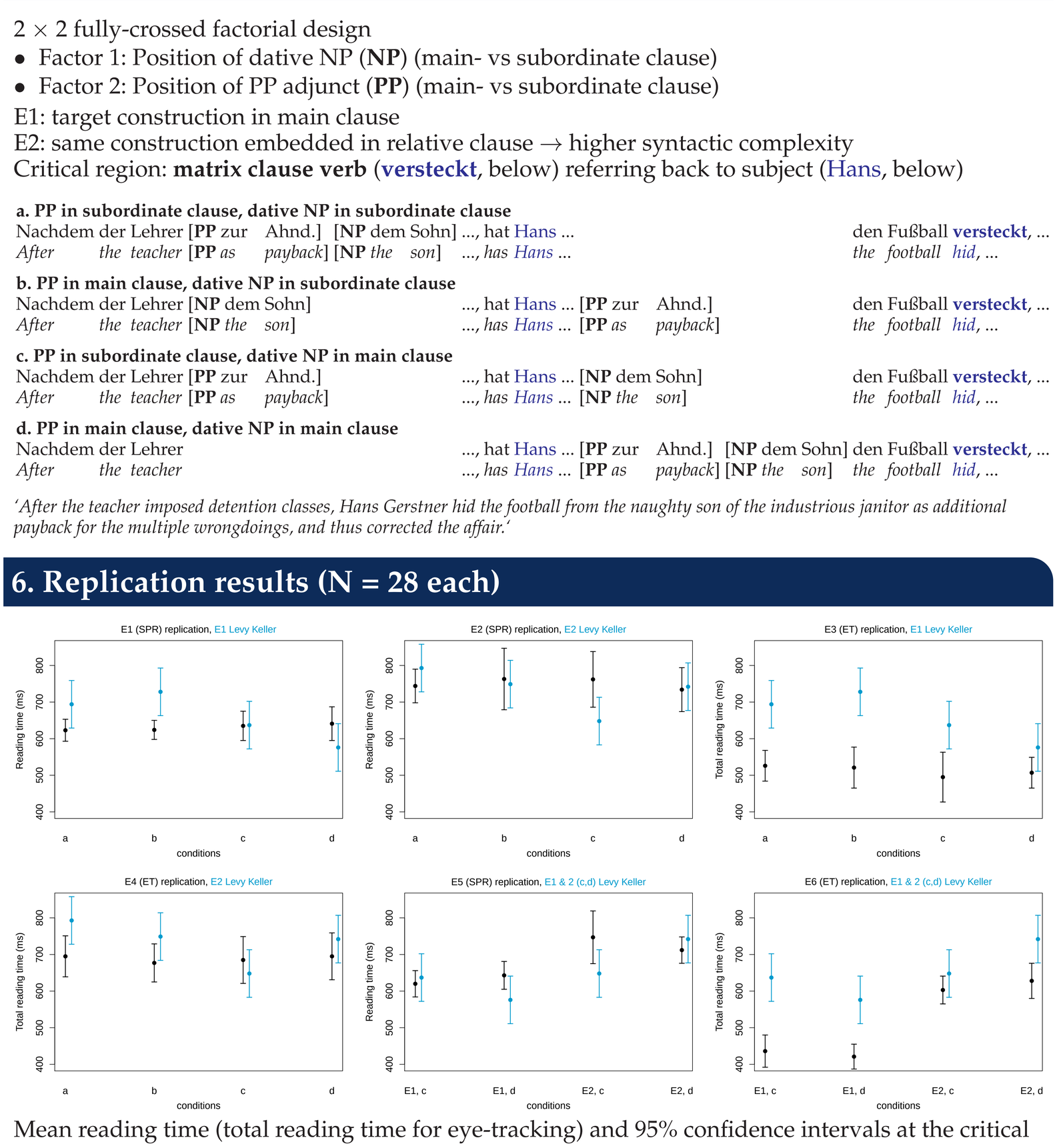
b. PP in main clause, dative NP in subordinate clause
Nachdem der Lehrer [**NP** dem Sohn] ..., hat Hans ... [**PP** zur Ahnd.] den Fußball **versteckt**, ...
After the teacher [**NP** *the son*] ..., *has Hans* ... [**PP** *as payback*] *the football hid*, ...

c. PP in subordinate clause, dative NP in main clause
Nachdem der Lehrer [**PP** zur Ahnd.] ..., hat Hans ... [**NP** dem Sohn] den Fußball **versteckt**, ...
After the teacher [**PP** *as payback*] ..., *has Hans* ... [**NP** *the son*] *the football hid*, ...

d. PP in main clause, dative NP in main clause
Nachdem der Lehrer ..., hat Hans ... [**PP** zur Ahnd.] [**NP** dem Sohn] den Fußball **versteckt**, ...
After the teacher ..., *has Hans* ... [**PP** *as payback*] [**NP** *the son*] *the football hid*, ...

'After the teacher imposed detention classes, Hans Gerstner hid the football from the naughty son of the industrious janitor as additional payback for the multiple wrongdoings, and thus corrected the affair.'

6. Replication results (N = 28 each)



Mean reading time (total reading time for eye-tracking) and 95% confidence intervals at the critical verb (**versteckt**) of original studies vs our replication attempts (our E5 and 6 combine cond. c, d of E1 and E2 by Levy & Keller as only these showed a statistically significant effect)