

Contributions of inhibitory control to individual differences in word production

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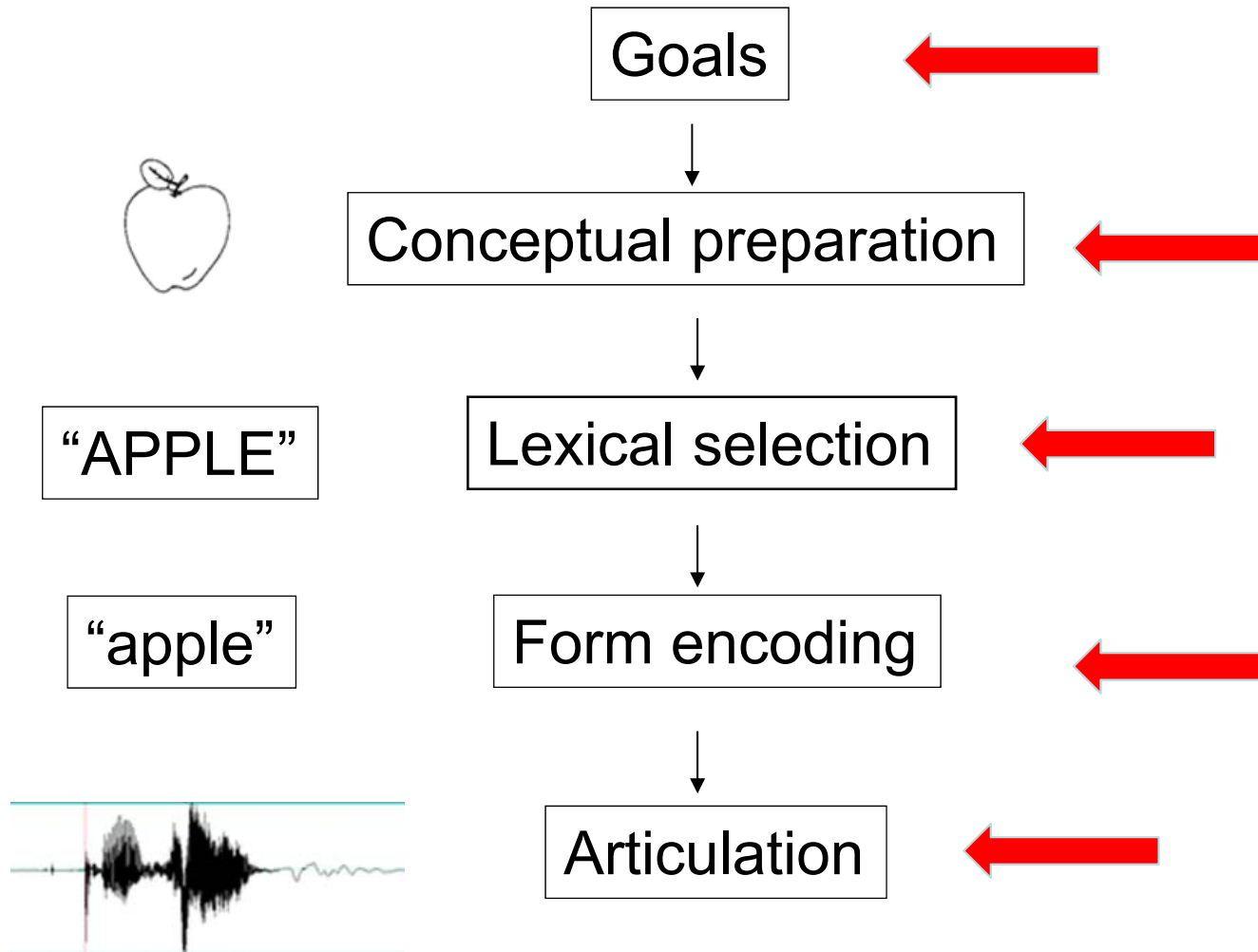
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Introduction: A Model of Word Production



(e.g., Levelt, Roelofs, & Meyer, 1999)

Introduction: Inhibition

- Definition:
 - The ability to suppress irrelevant or interfering stimuli or impulses with or without intention (Garavan et al., 1999; Macleod, 2007).
- Some evidence:
 - Bilingual speakers have better inhibition ability (e.g., Guo et al., 2012, but see Singh & Mishra, 2011).
 - Individuals with specific language impairment also have inhibition deficits (Spaulding, 2010).

Forms of inhibition

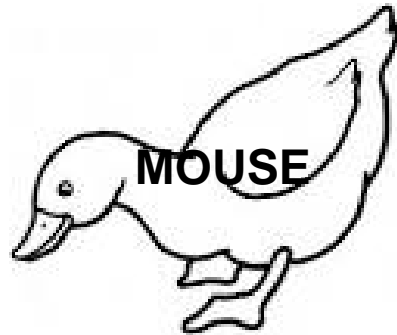
- Non-selective inhibition: Stopping ANY response (Logan & Cowan, 1984).
- Selective inhibition: Suppressing a competitor (Forstman et al., 2008; van den Wildenberg et al., 2010).

Research Questions

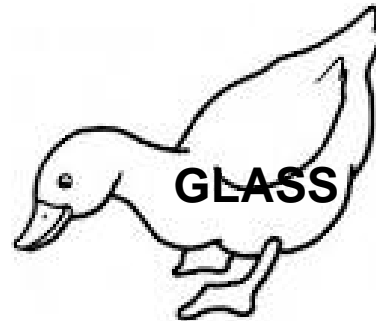
- Do different types of inhibition play different roles in word production?
- How and when is inhibition engaged in word production?

Study 1

- Participants: 88 native Dutch speakers (14 men, *Mean age* = 30.15 years, range: 16 to 63 years).
- Picture-word interference task: 56 objects



Semantically related

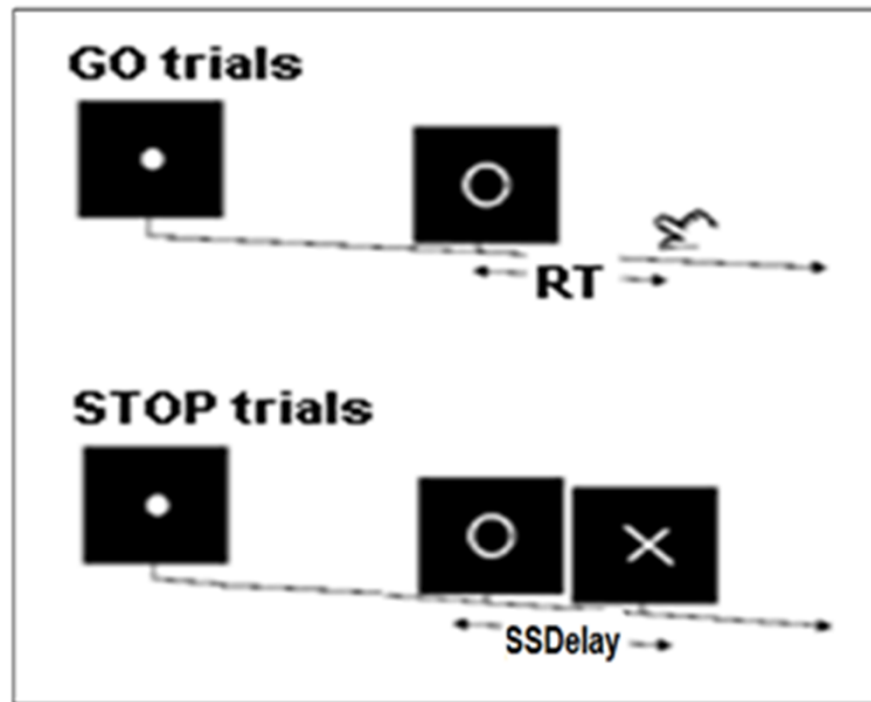


Unrelated

(Shao et al., Memory & Cognition, 2013)

Study 1

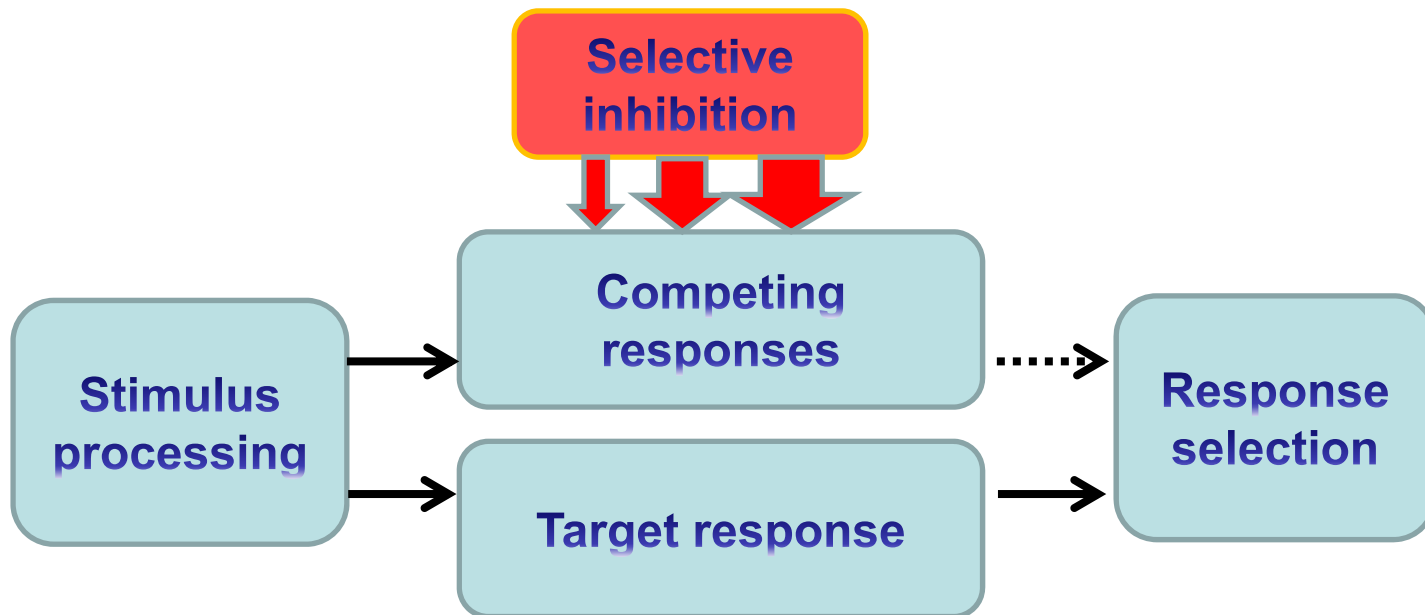
- Stop-signal task to measure non-selective inhibition (Verbruggen, Logan & Stevens, 2008).



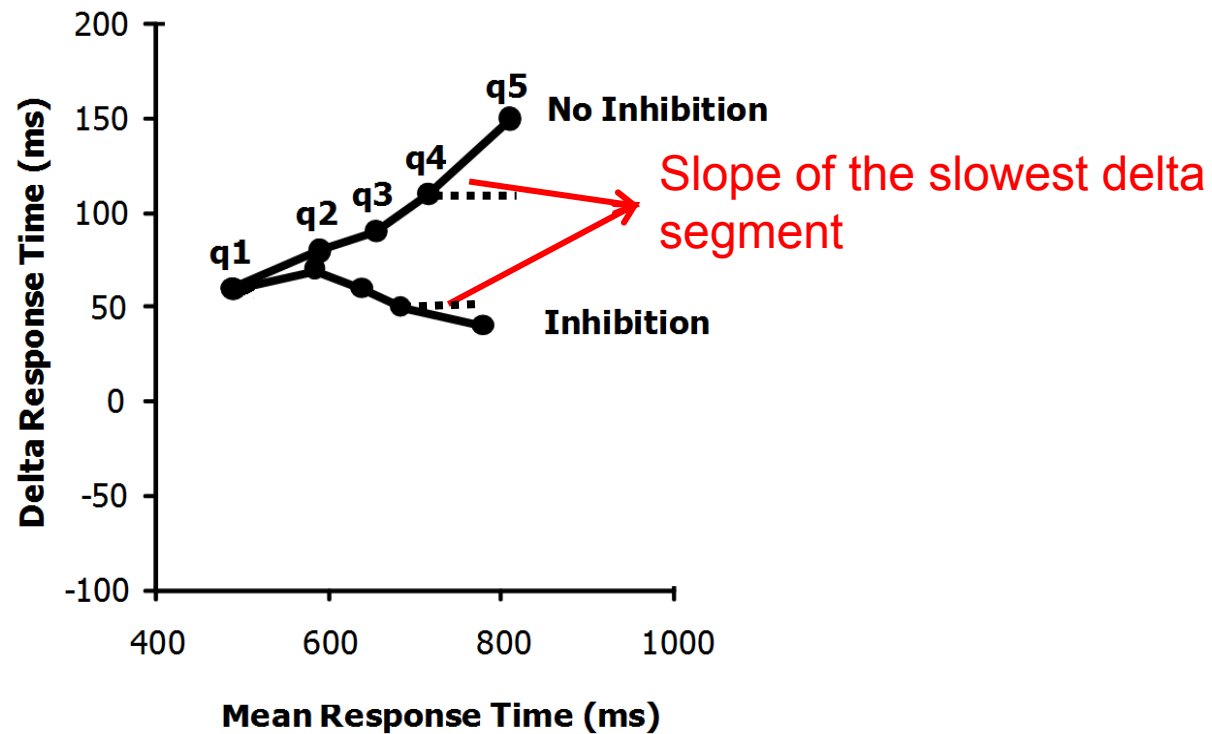
Study 1: Indicators of selective inhibition

- Delta plot to measure selective inhibition:
 - RT distribution analysis in response conflicting task (Ridderinkhof, 2002)

Delta = RT in difficult condition – RT in easy condition

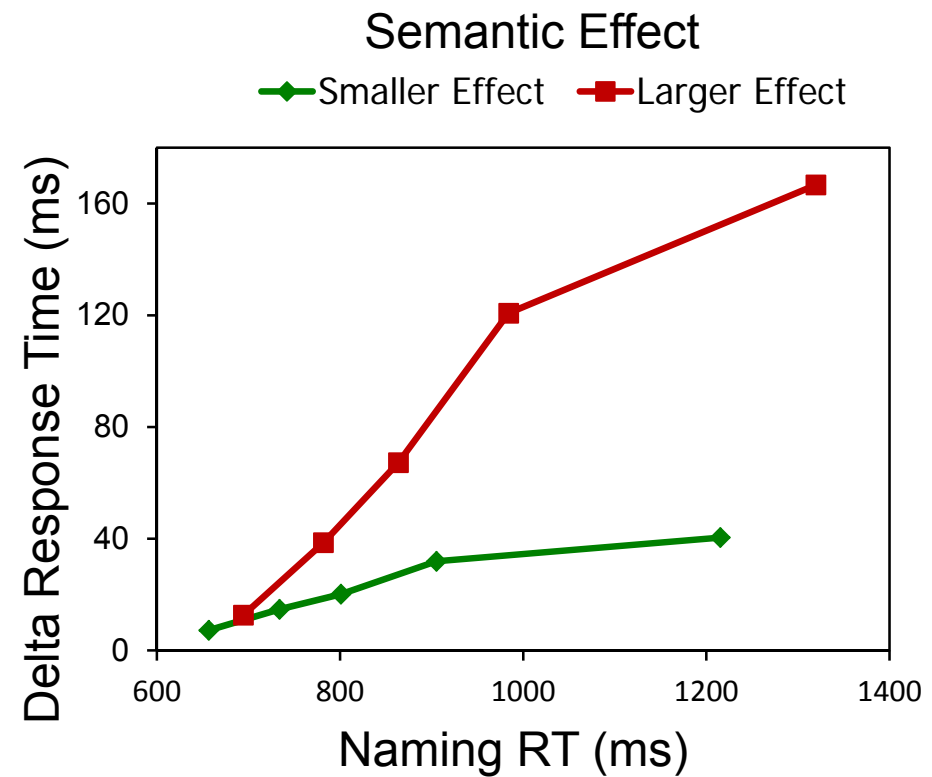
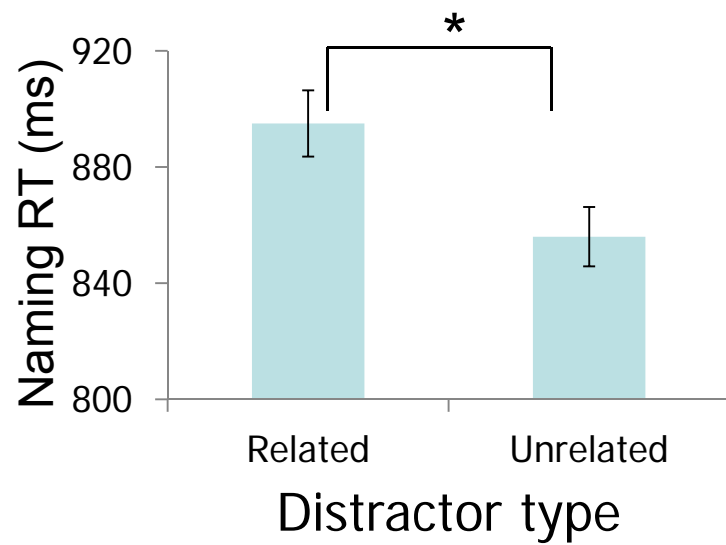


Study 1: Delta plots



$$\text{Slope } (x, y) = \frac{\text{Delta (Quintile } y) - \text{Delta (Quintile } x)}{\text{Mean (Quintile } y) - \text{Mean (Quintile } x)}}$$

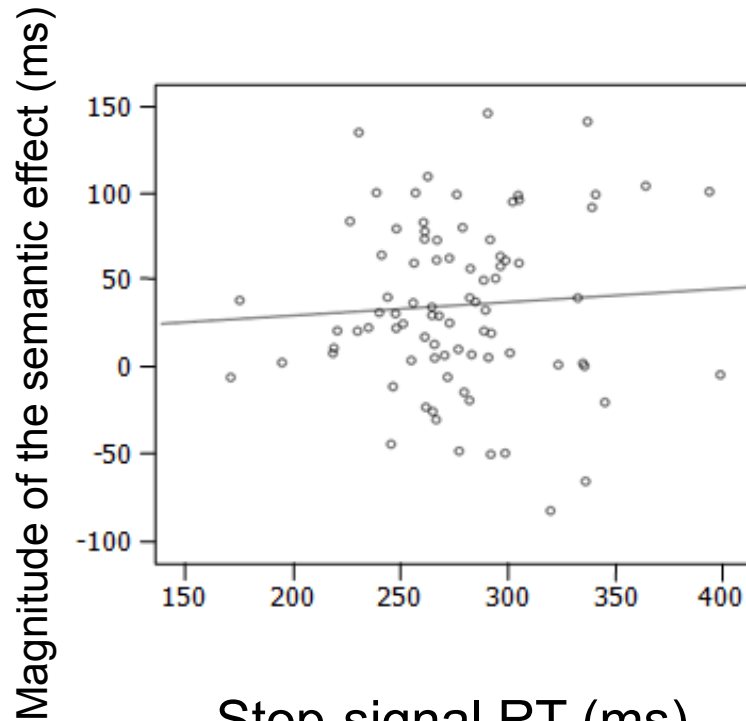
Study 1



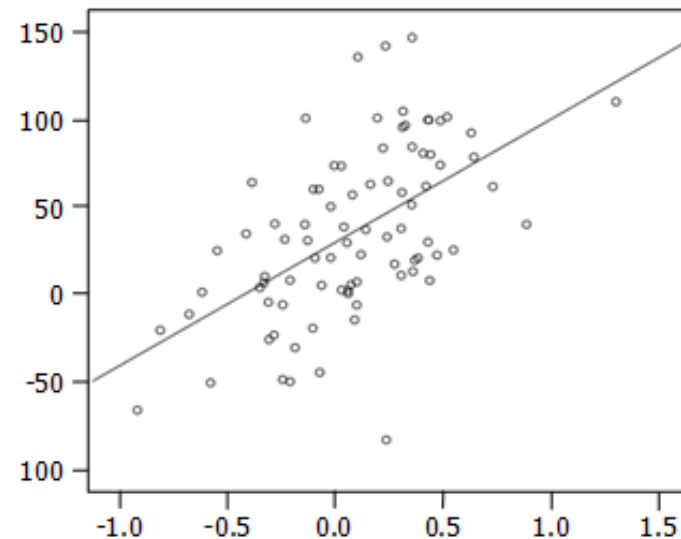
(Shao et al., Memory & Cognition, 2013)

Study 1

Correlation between semantic effects and two types of inhibition.



Stop-signal RT (ms)
 $r = .12$

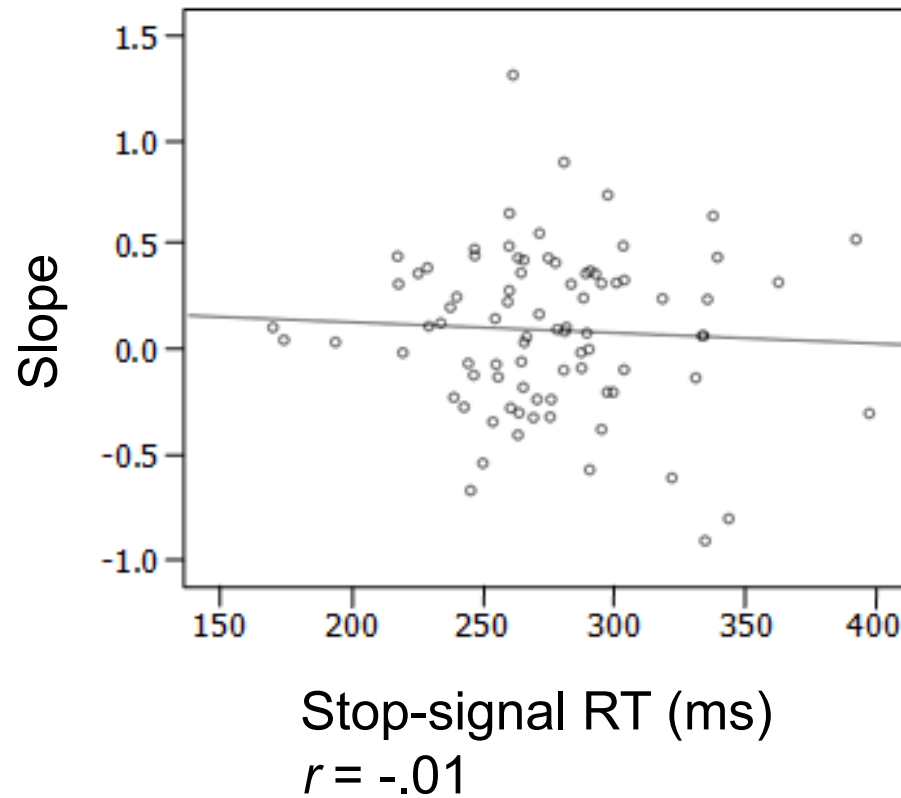


Slope of the slowest delta
segment, $r = .63$

(Shao et al., Memory & Cognition, 2013)

Study 1

Correlation between selective and non-selective inhibition.



(Shao et al., Memory & Cognition, 2013)

Interim Conclusions

- Do different types of inhibition play different roles in word production?
 - Yes.
 - Selective inhibition helps to suppress the activation of overt strong competitors.
- Question: Does selective inhibition is engaged only when salient competitor is presented?

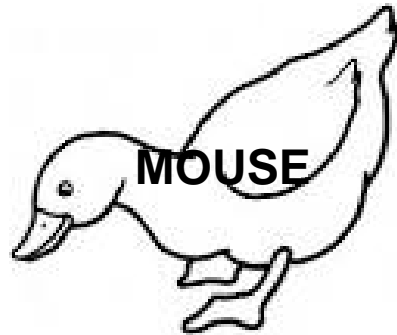
Study 2

- Participants: 25 native Dutch speakers (9 men, *Mean age* = 21.16 years, range: 18 to 27 years).
- Naming tasks:
 - Picture-word interference task
 - Semantic blocking task
 - Stroop task
- Non-selective inhibition: Stop-signal task.
- Selective inhibition: Delta plot

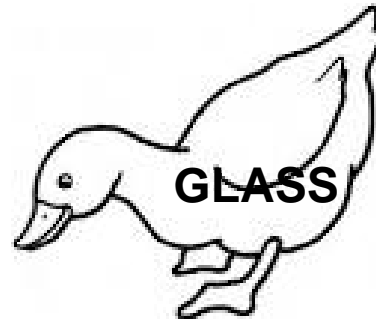
(Shao et al., JEP:LMC, in press)

Study 2

- Picture-word interference task:



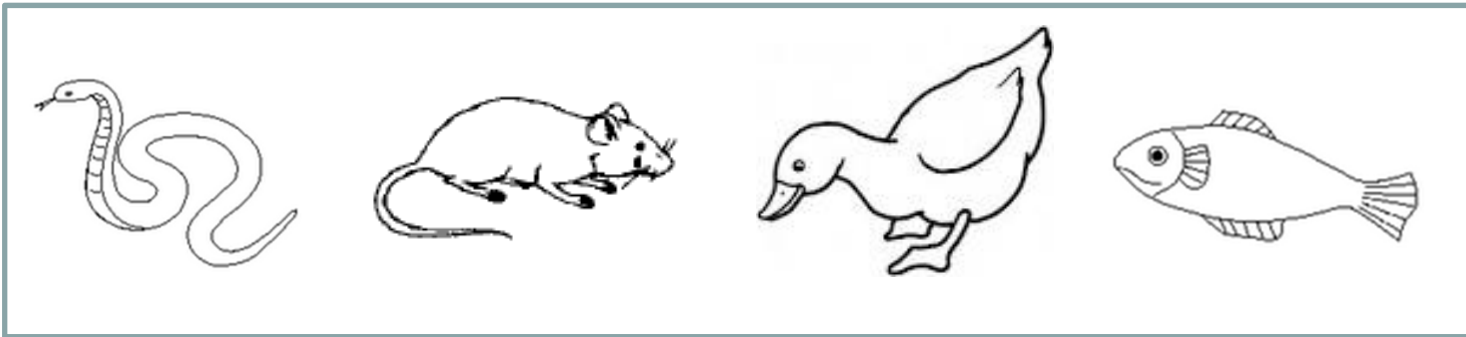
Semantically related



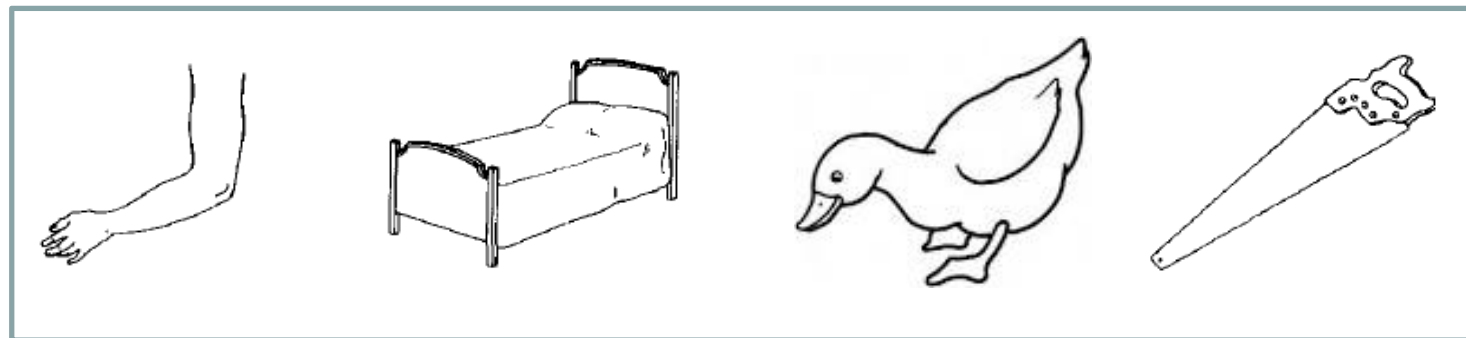
Unrelated

Study 2

- Semantic blocking task:
 - Homogenous block



- Heterogeneous block



Study 2

- Word-color Stroop task:

Green

xxx

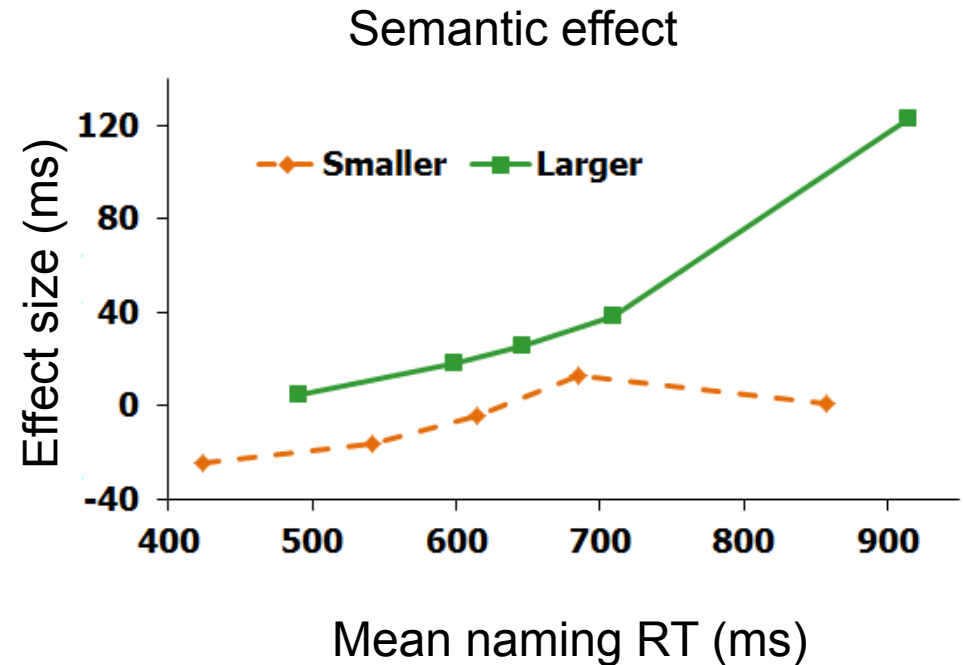
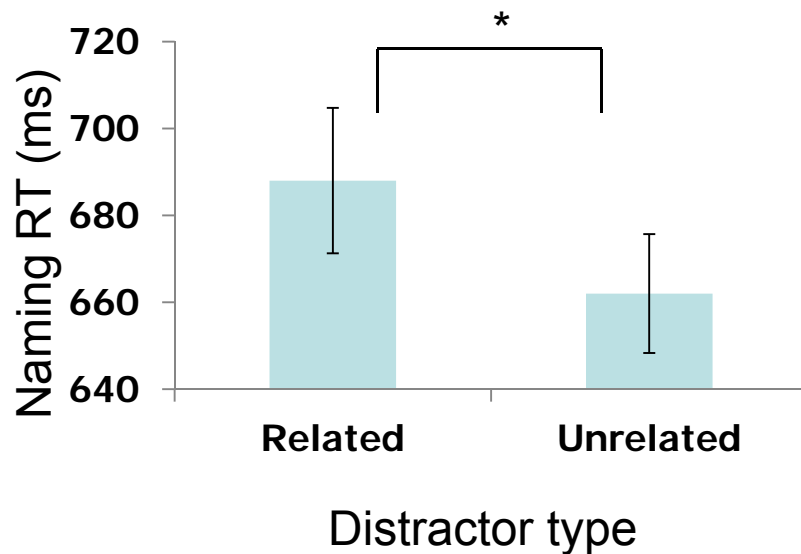
Red

incongruent

neutral

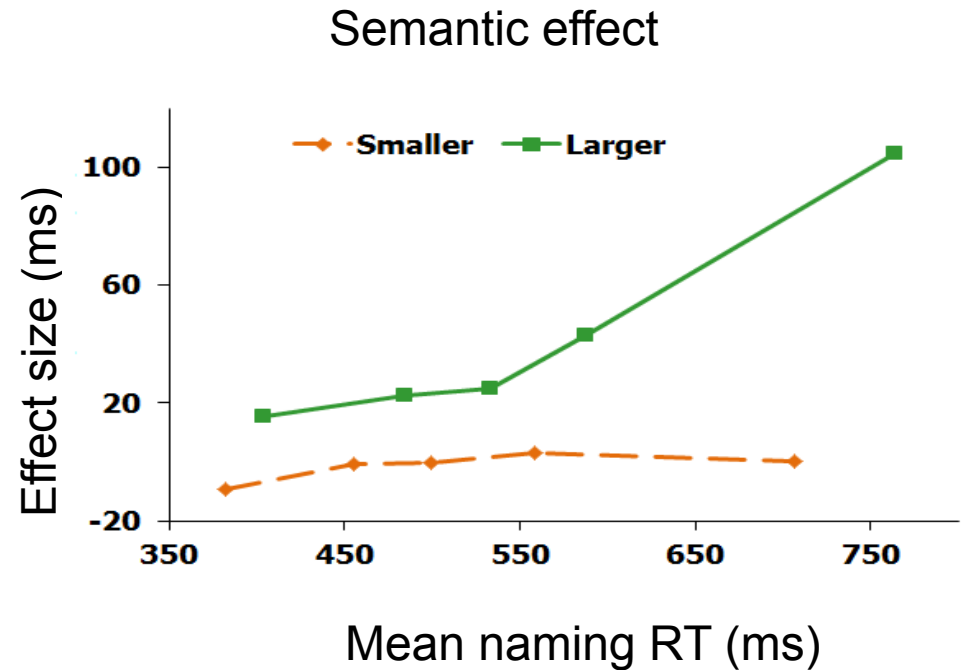
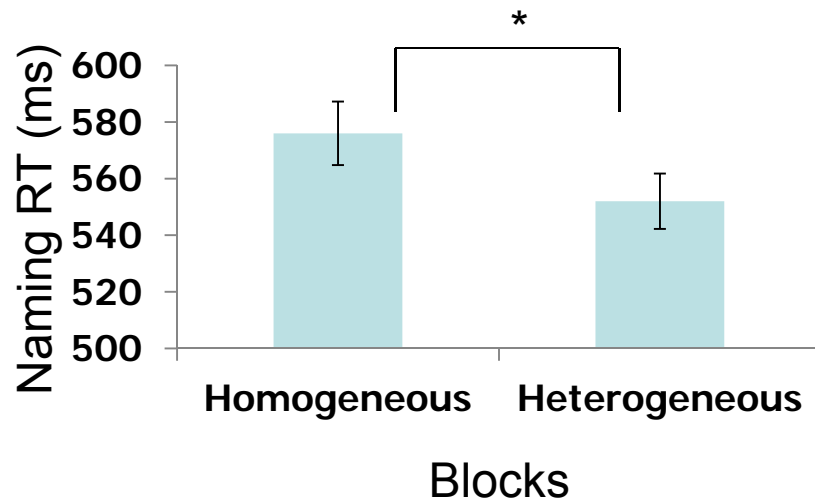
congruent

Study 2: Results of picture-word interference task



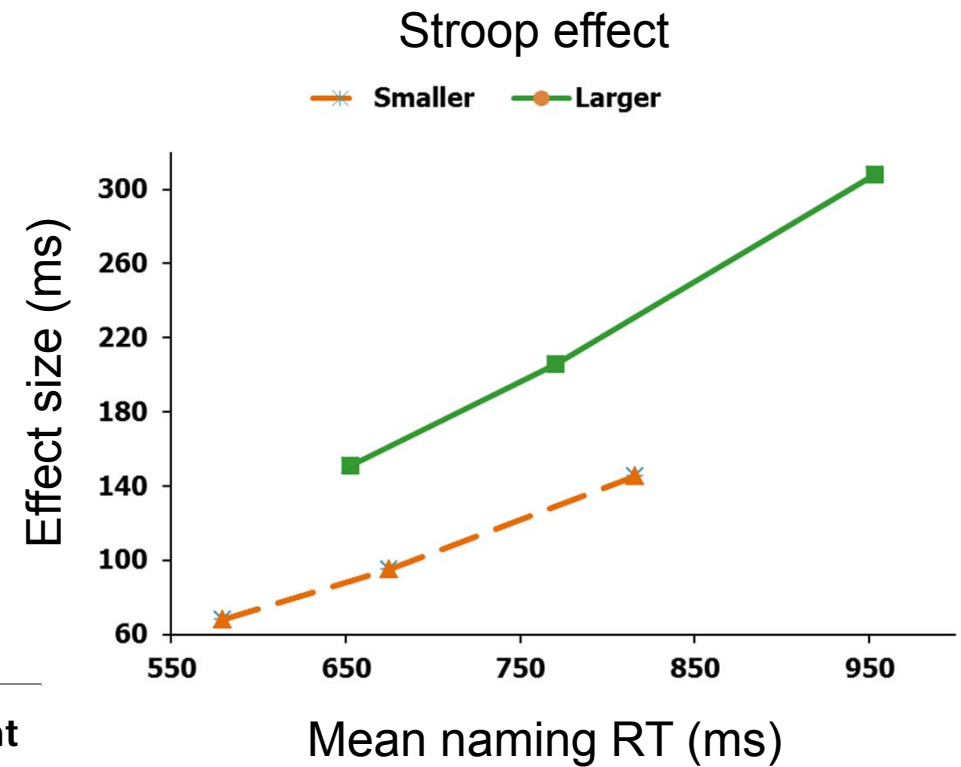
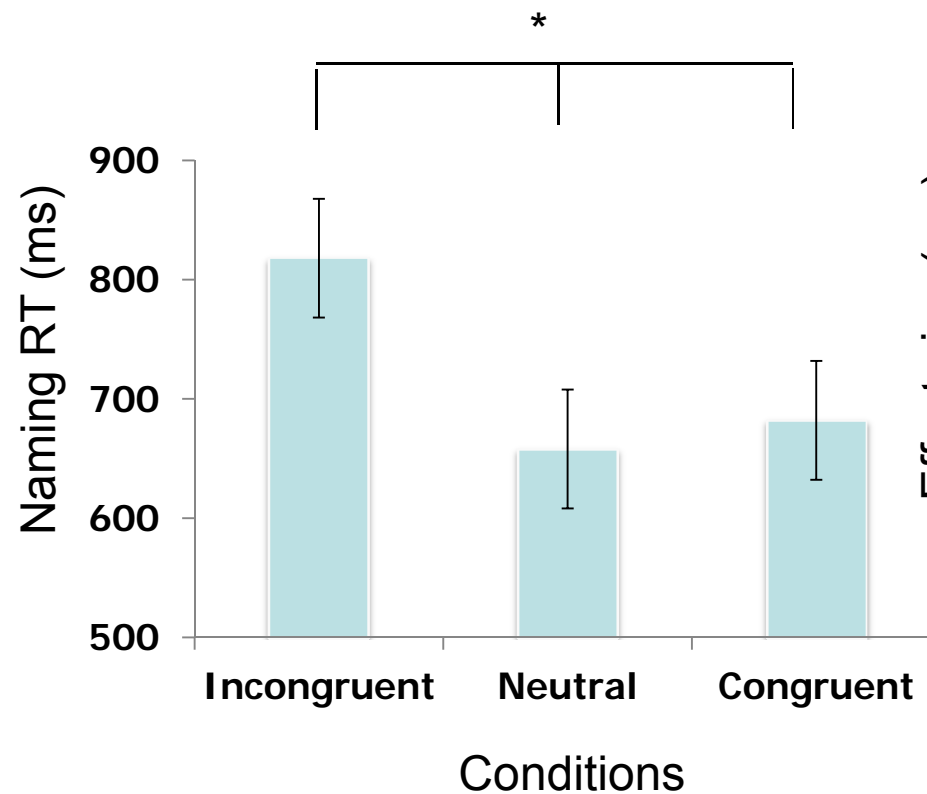
(Shao et al., JEP:LMC, in press)

Study 2: Results of semantic blocking task



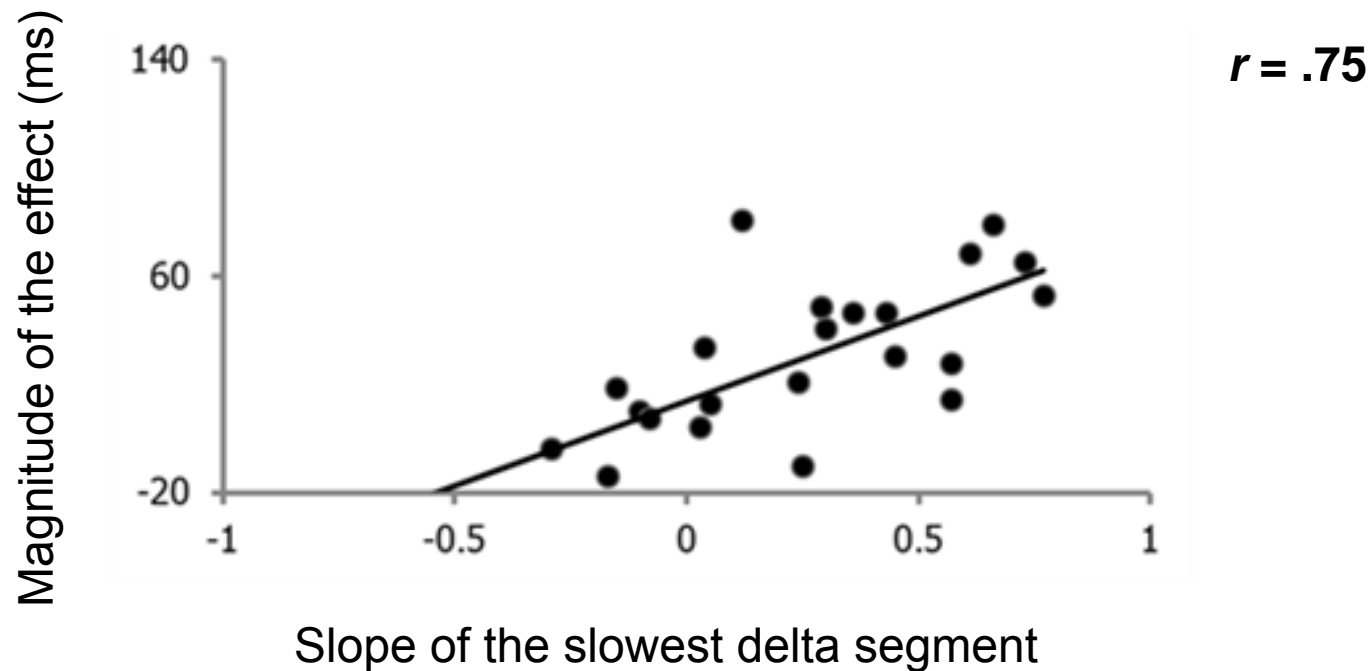
(Shao et al., JEP:LMC, in press)

Study 2: Results of Stroop task



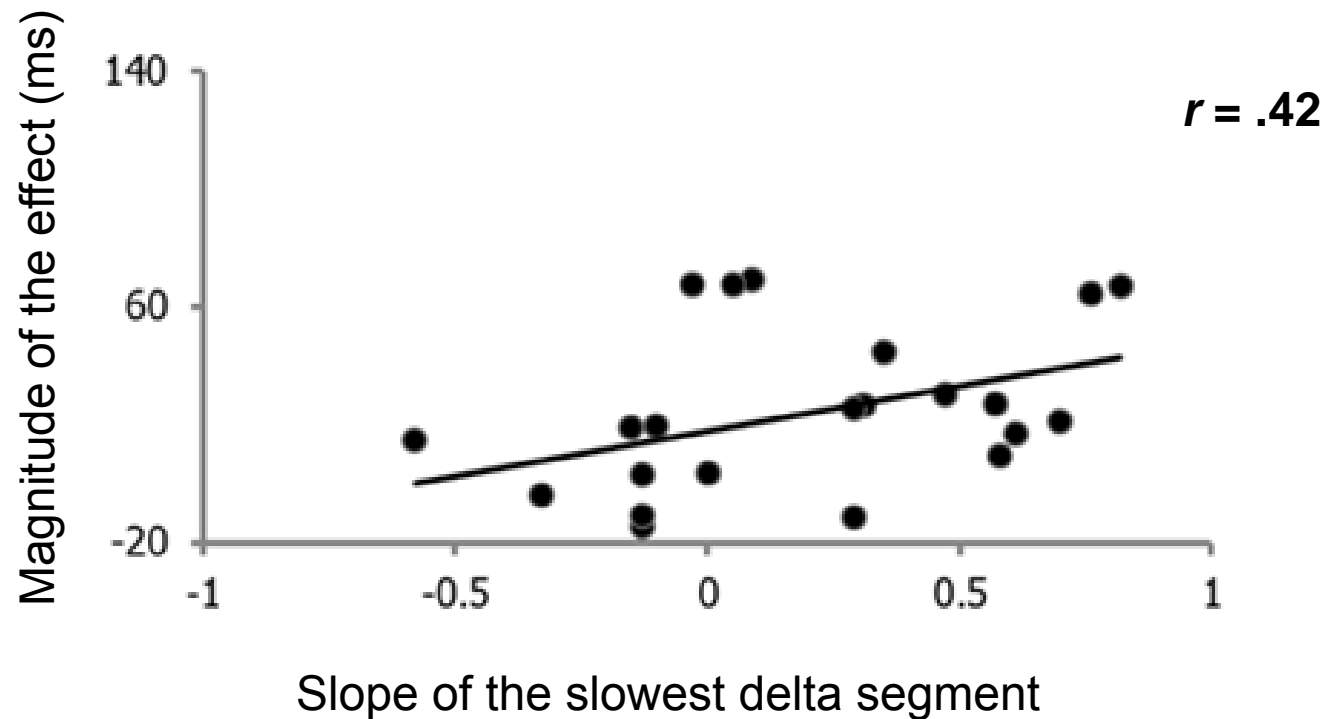
(Shao et al., JEP:LMC, in press)

Study 2: Correlations between slope and semantic interference effect size



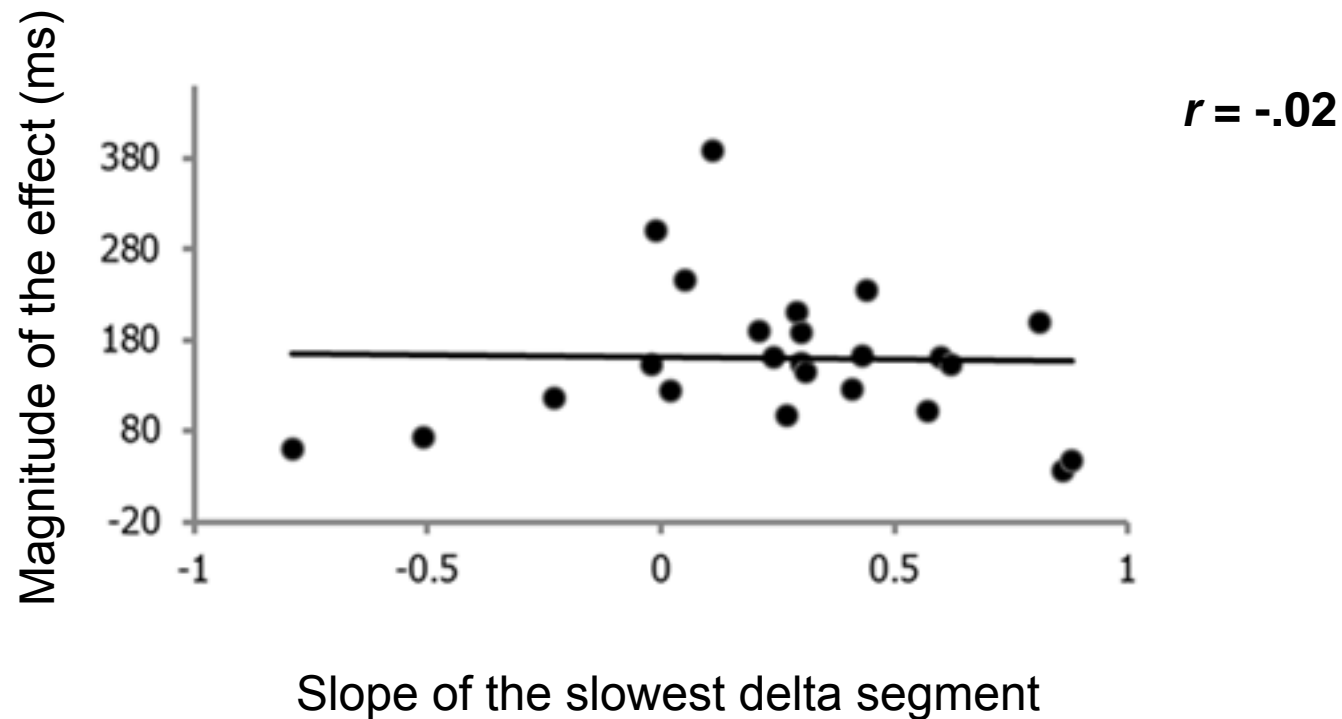
(Shao et al., JEP:LMC, in press)

Study 2: Correlations between slope and semantic block effect size



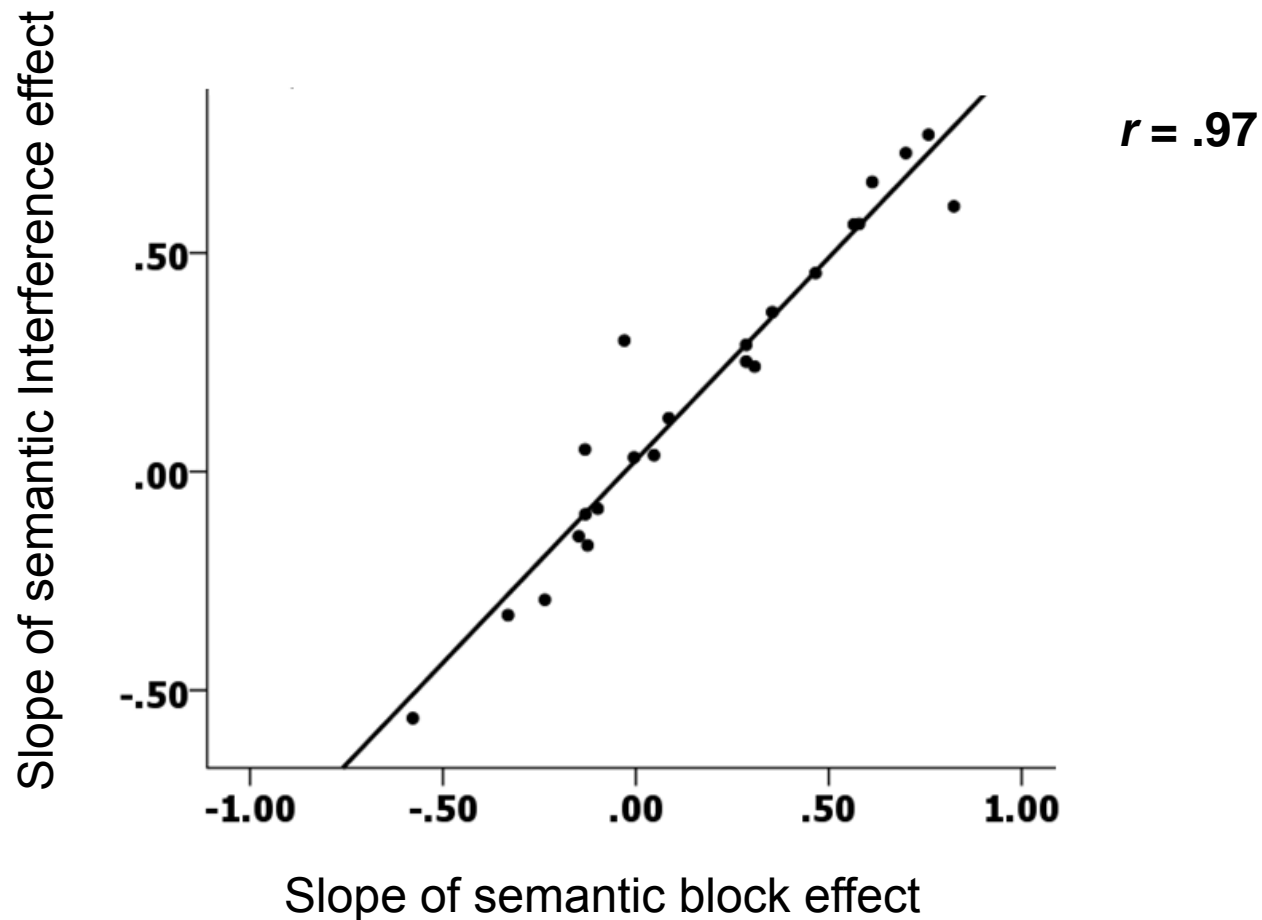
(Shao et al., JEP:LMC, in press)

Study 2: Correlations between slope and Stroop effect size



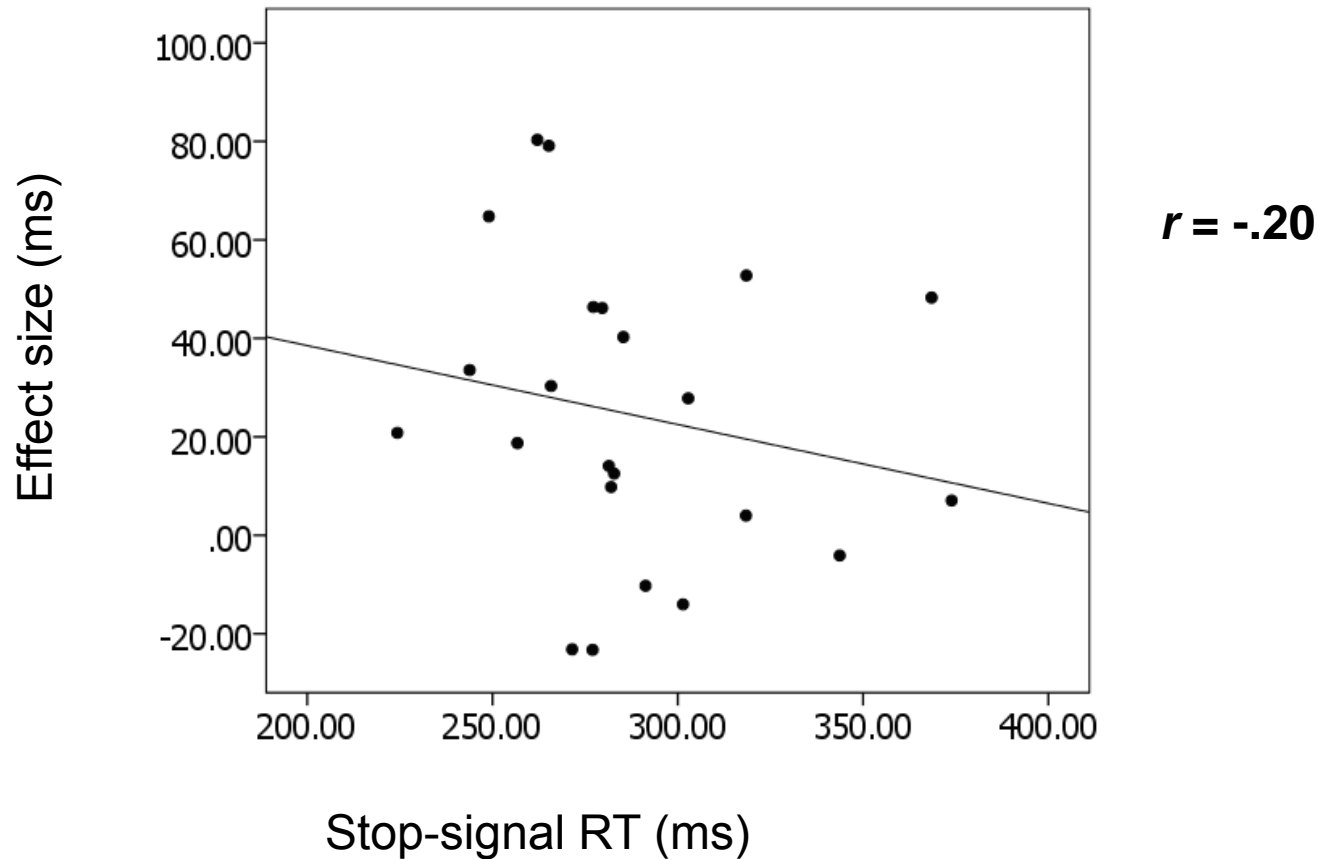
(Shao et al., JEP:LMC, in press)

Study 2: Correlations between slopes in both naming tasks



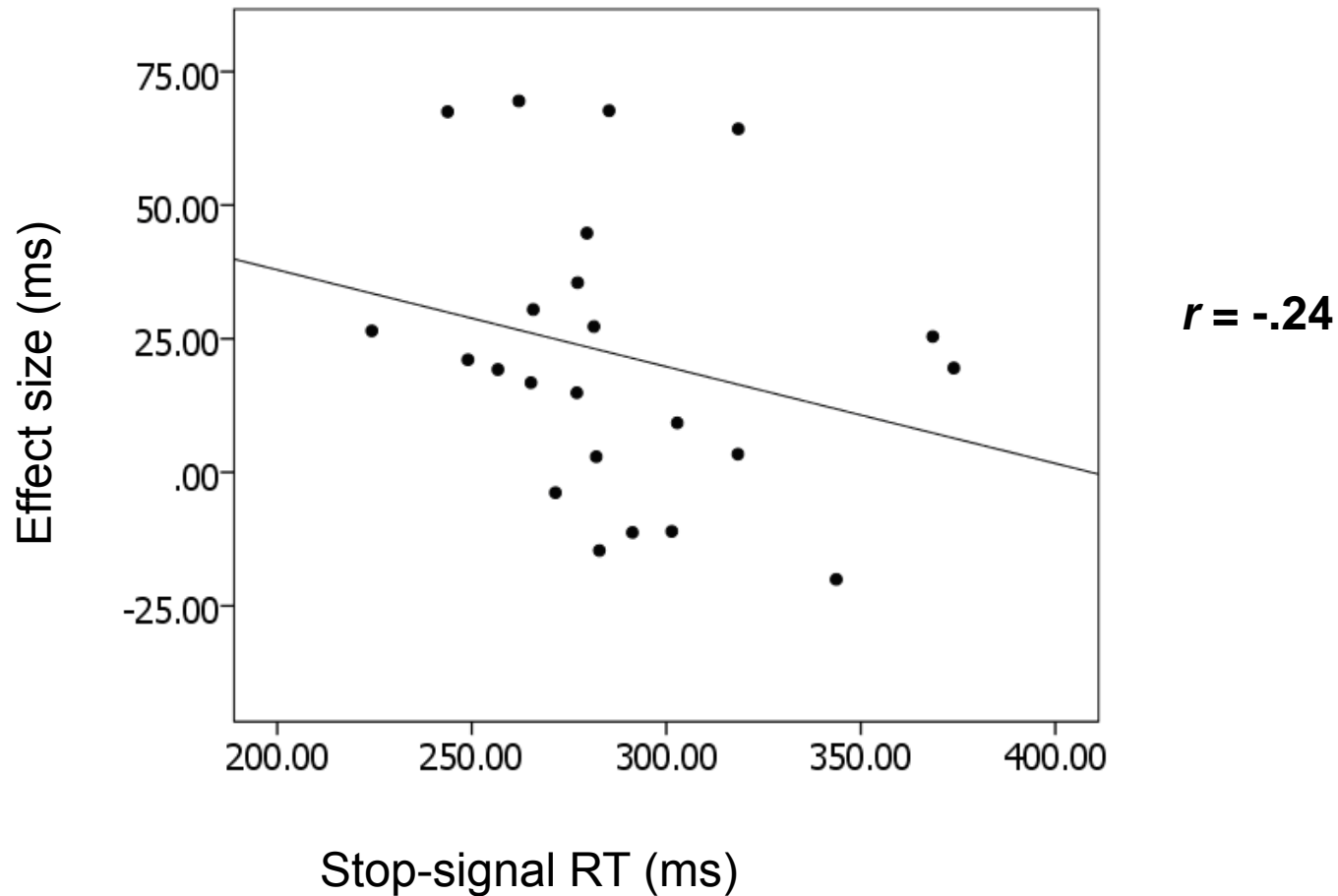
(Shao et al., JEP:LMC, in press)

Study 2: Correlations between SSRT and semantic interference effect size



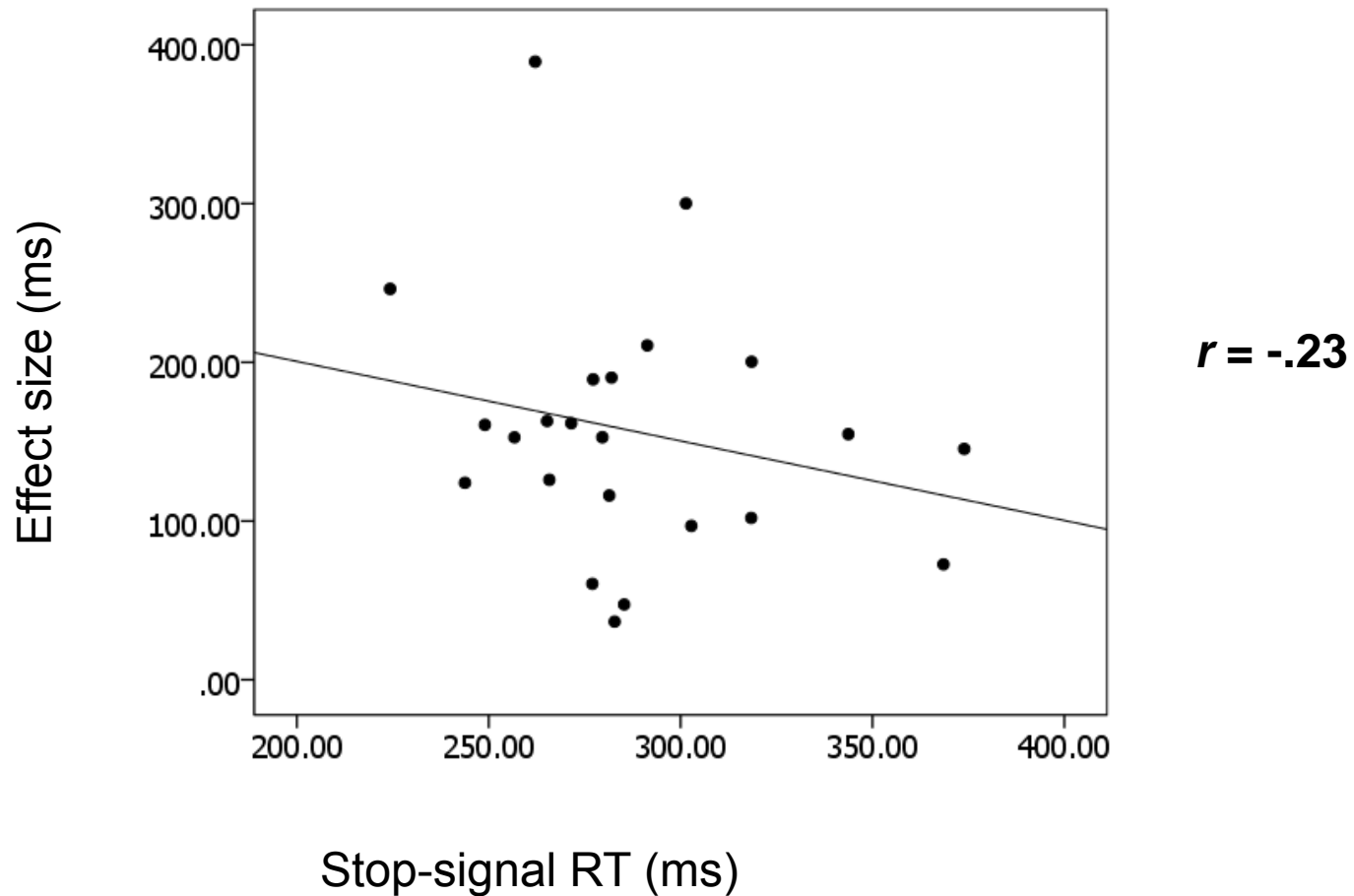
(Shao et al., JEP:LMC, in press)

Study 2: Correlations between SSRT and semantic block effect size



(Shao et al., JEP:LMC, in press)

Study 2: Correlations between SSRT and Stroop effect size



(Shao et al., JEP:LMC, in press)

Study 2

- Replicating with different items:
 - Positive correlations between slopes of and effect size in the picture-word interference task, $r = .59$, and semantic block task, $r = .62$, but not in the Stroop task, $r = .18$.
 - No correlations between stop-signal RT and effect sizes in all tasks, $r_s < .19$.

(Shao et al., JEP:LMC, in press)

Interim Conclusions

- Selective inhibition helps to reduce strongly co-activated competitors:
 - when one single salient distractor is presented
 - or when the strong competitors are evoked through the preceding context.

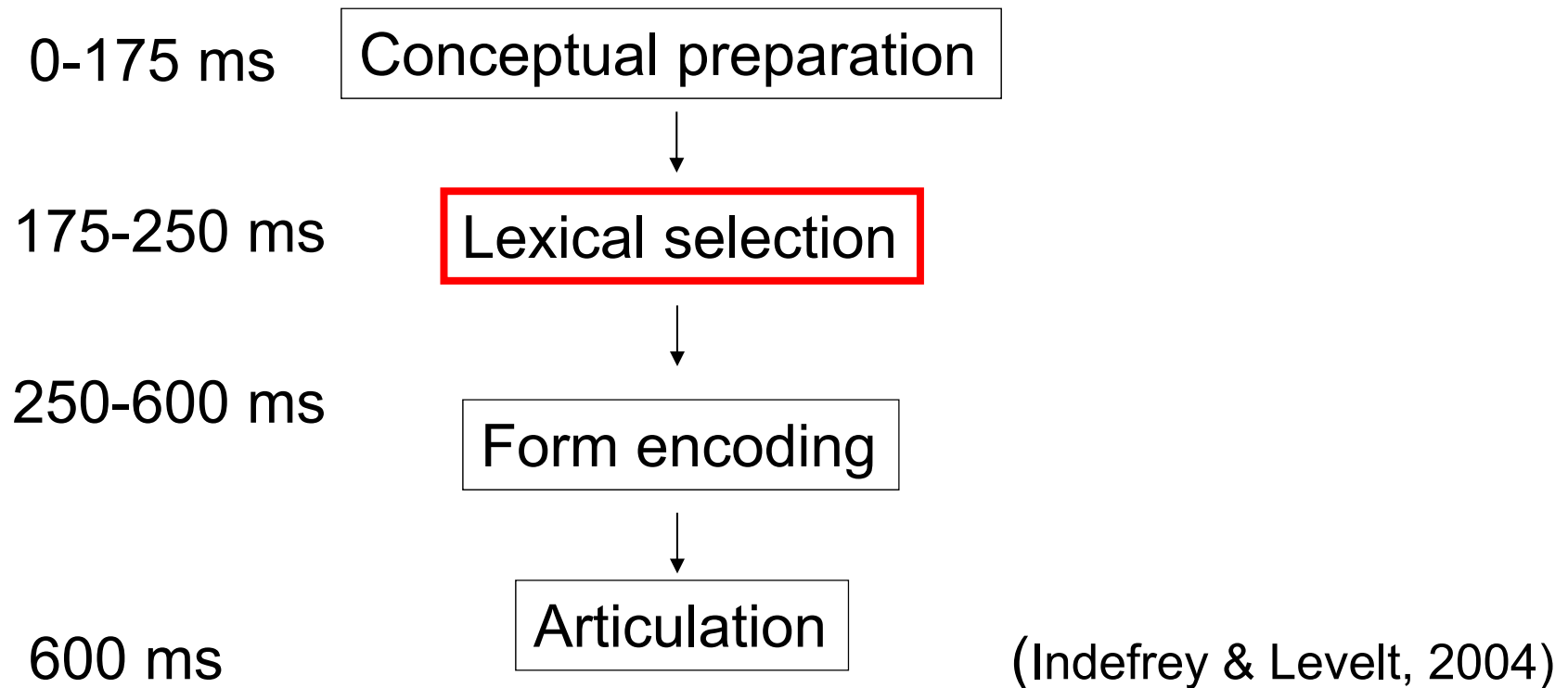
Study 3

- Question: When is selective inhibition engaged in word production?
- EEG evidence.



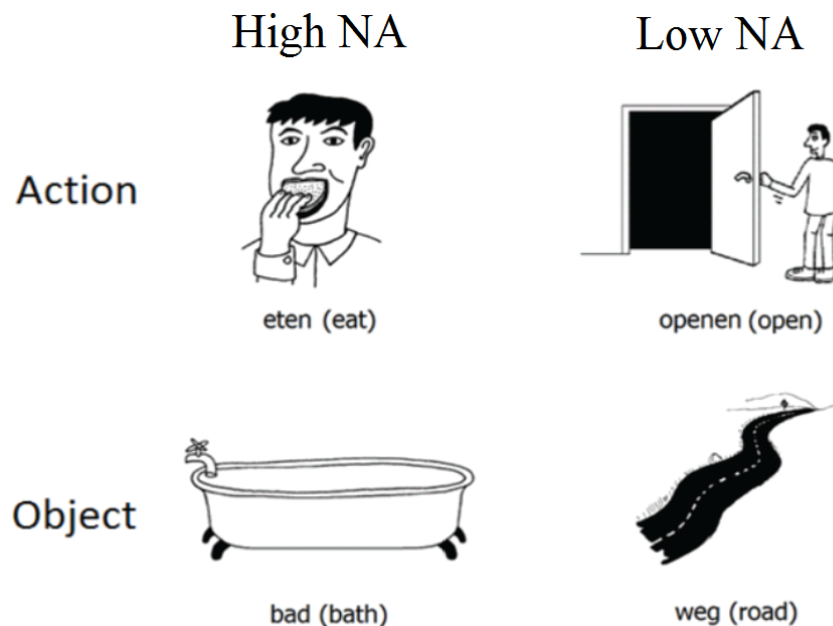
Study 3

- Time course of word production:



Study 3

- Name agreement (NA):
 - The extent to which different people agree on a name for a particular picture.



(Shao et al., Brain Research, 2014)

Study 3

- N2 component:
 - Associated with a domain-general inhibitory mechanism (Dong et al., 2009; Jodo & Kayama, 1992; Simson, Vaughan, & Ritter, 1977; Thorpe, Fize, & Marlot, 1996).
 - Peaking between 200 to 300 ms

Study 3

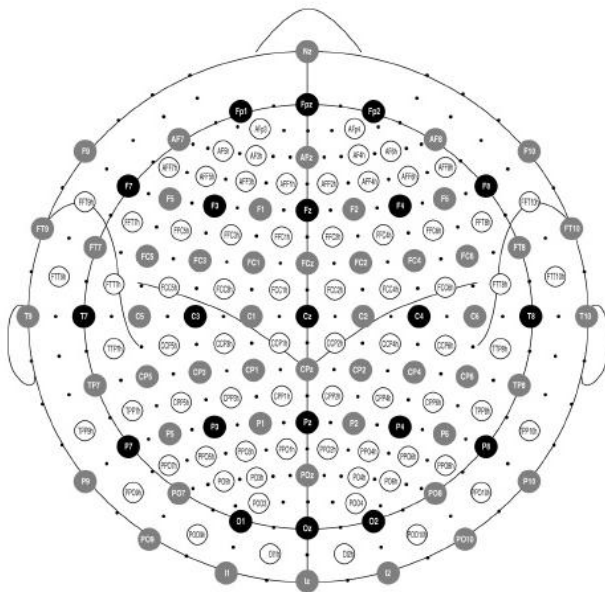
- Participants: 25 native Dutch speakers, *Mean age* = 21.04 years.
- Materials:
 - 160 objects and actions with high or low name agreement.
- Hypothesis: If selective inhibition helps lexical selection, we should observe more pronounced N2 in the low name agreement condition during the time window of lexical selection.

(Shao et al., Brain Research, 2014)

Study 3

- EEG recording

- 128 channels, acticap
- Sampling rate: 512 Hz

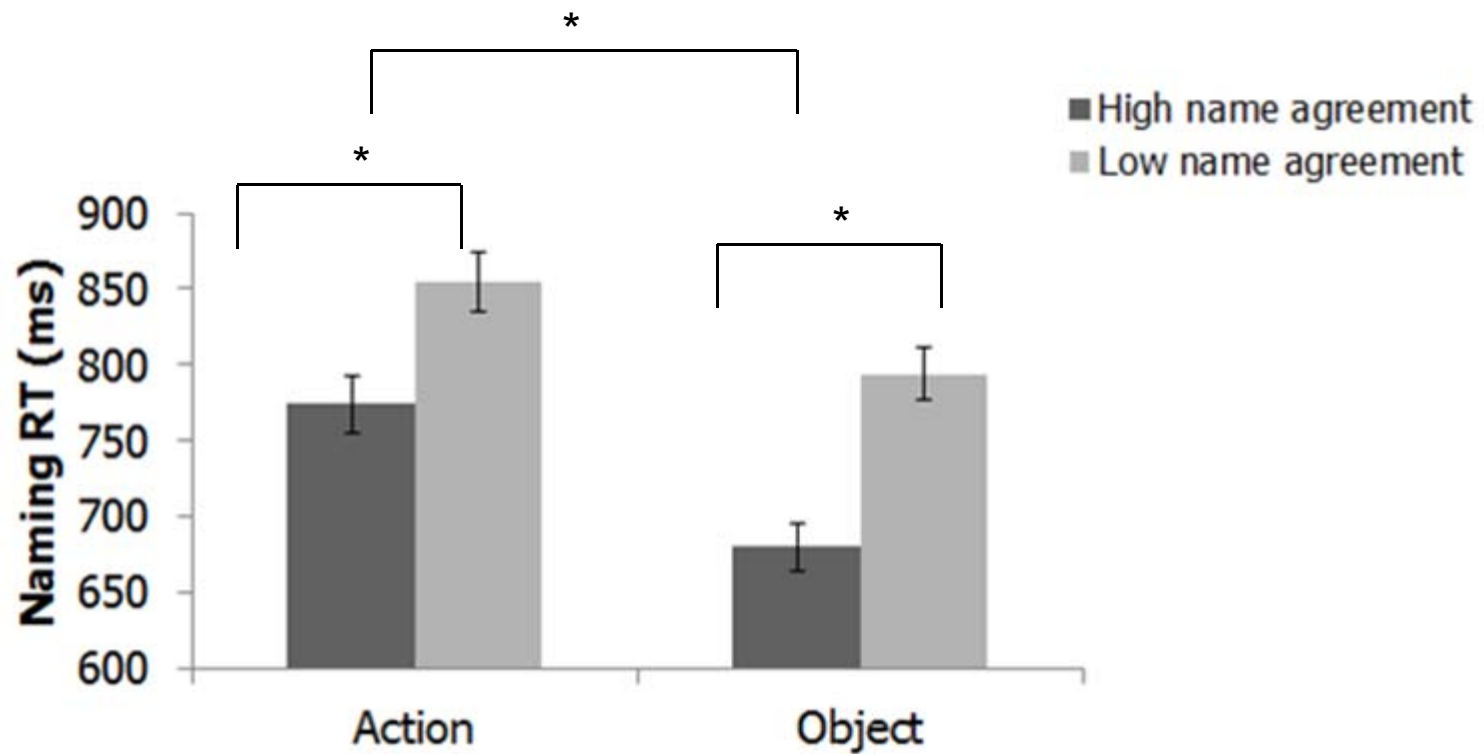


- Preprocessing

- Band pass filter: 0.05- 30Hz (48 dB)
- Epoch: -200 – 700 ms
- Time-locked to picture onset
- Baseline corrected: -200-0 ms
- Artifact rejection:
 - Amplitude criterion: $\pm 100\mu\text{V}$
 - Gradient criterion: $50.00\ \mu\text{V}$
 - Difference criterion: $150.00\ \mu\text{V}$

(Shao et al., Brain Research, 2014)

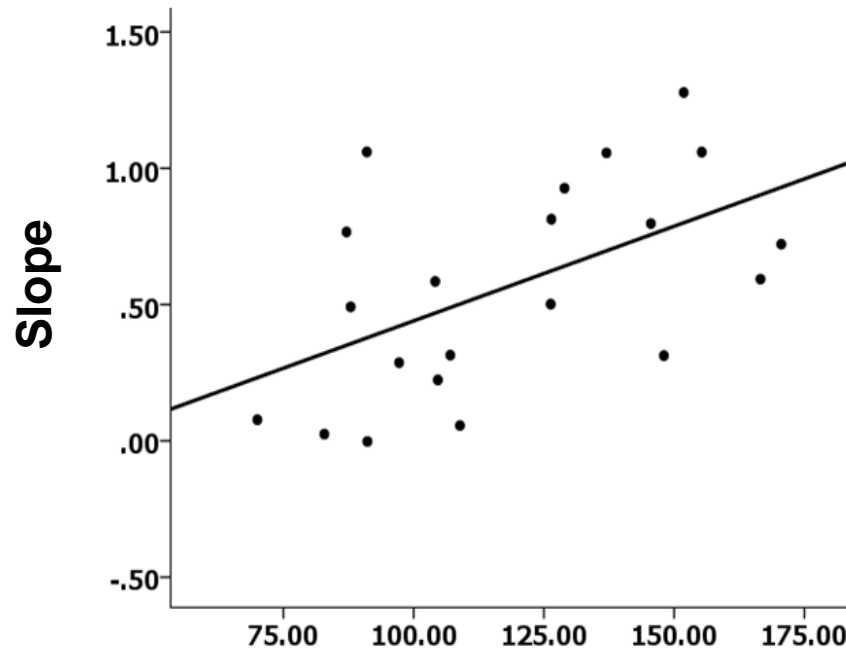
Study 3: Behavioral results



(Shao et al., Brain Research, 2014)

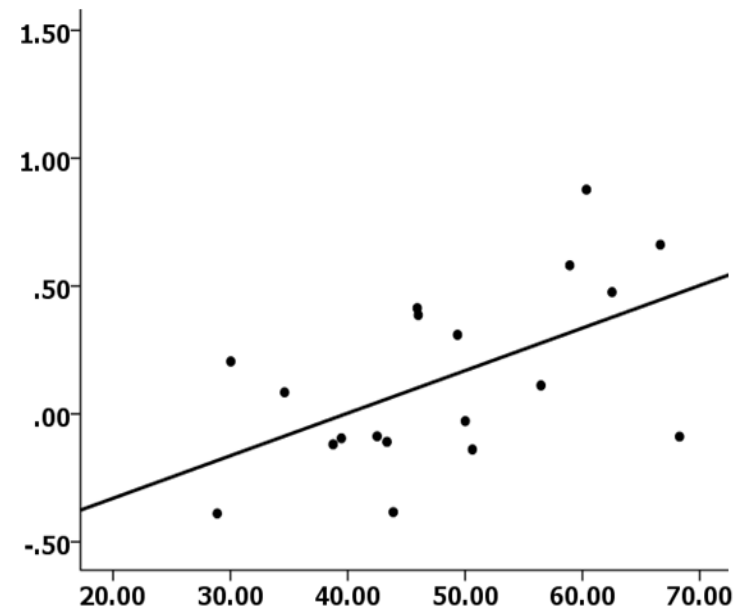
Study 3: Correlations between slope and size of name agreement effect

a) Object naming



$$r = .54^*$$

b) Action naming

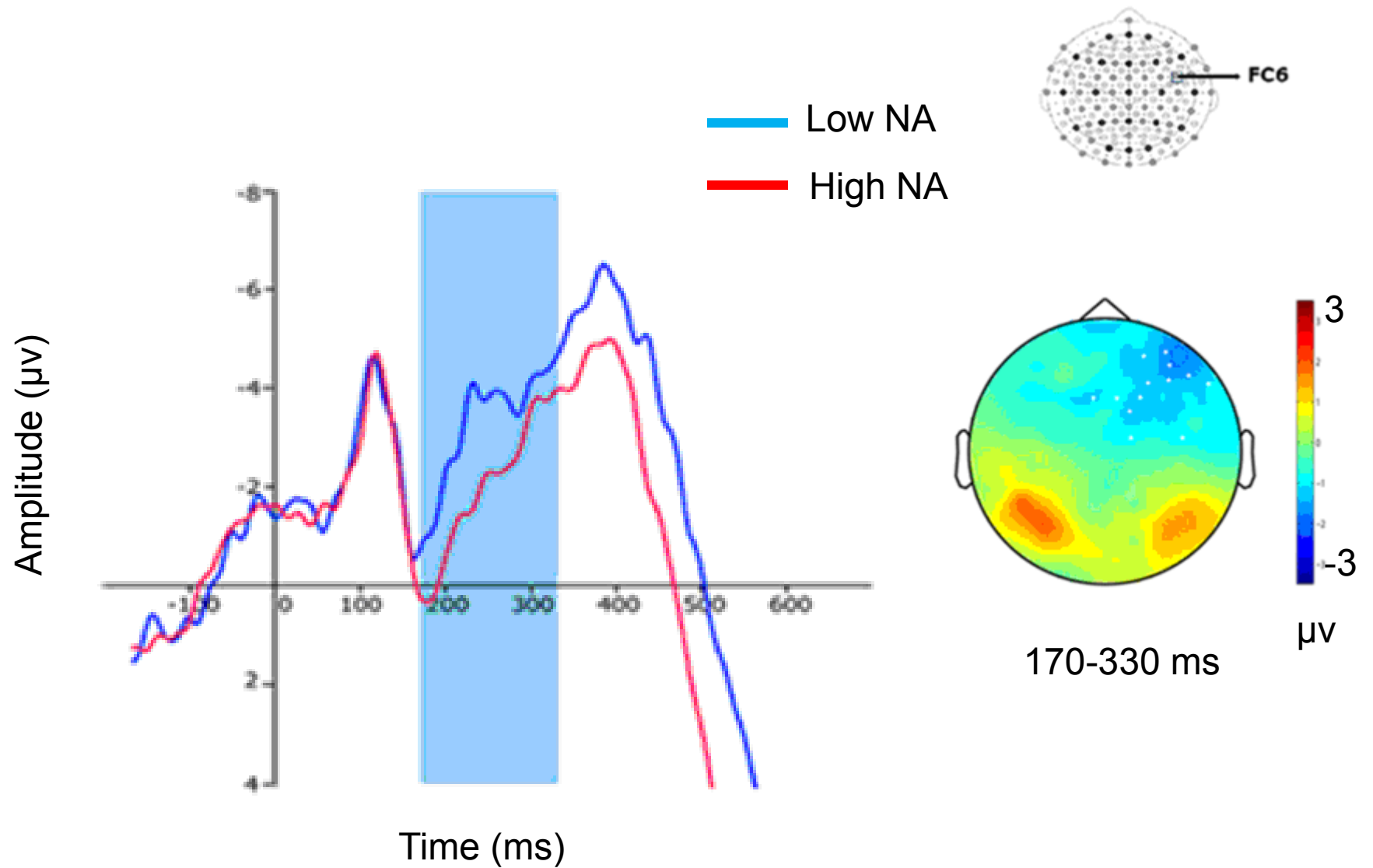


$$r = .58^*$$

Magnitude of name agreement effect (ms)

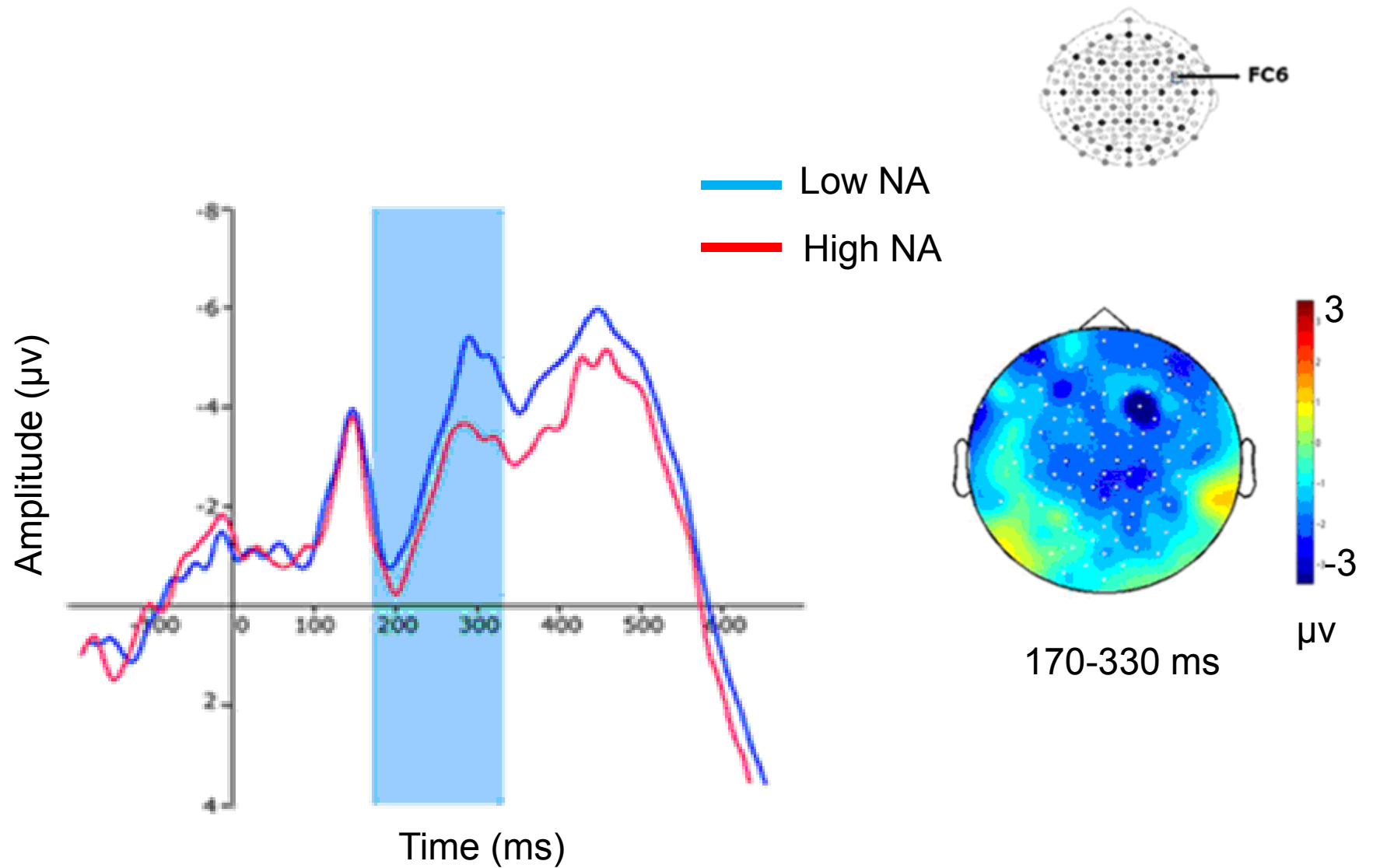
(Shao et al., Brain Research, 2014)

Study 3: Object naming results



(Shao et al., Brain Research, 2014)

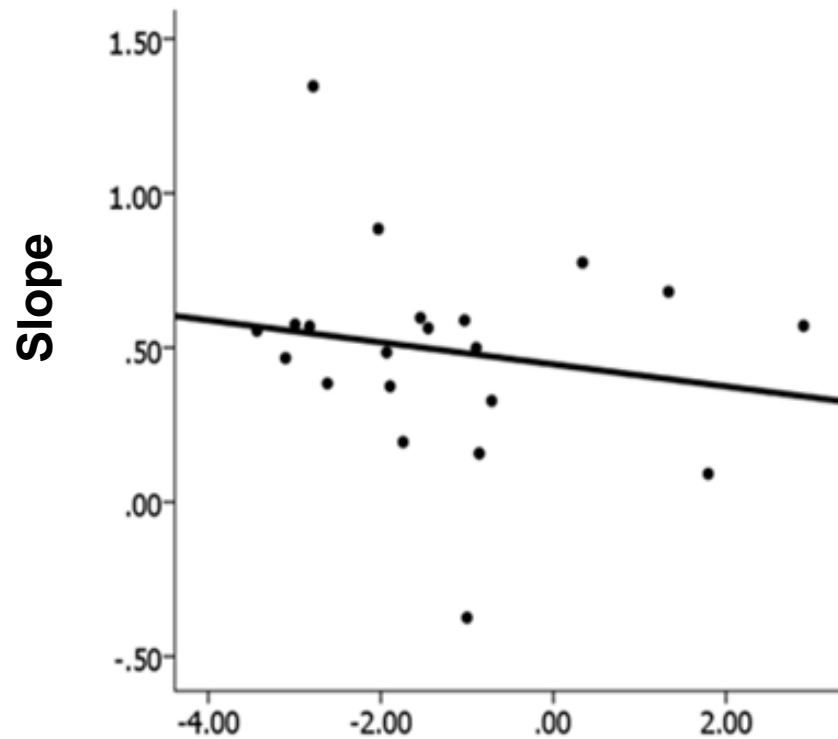
Study 3: Action naming results



(Shao et al., Brain Research, 2014)

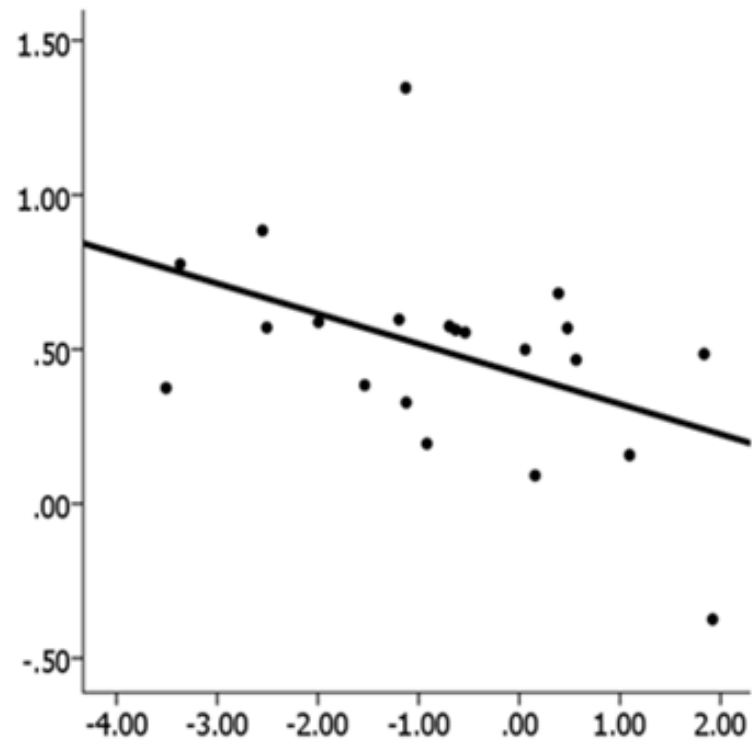
Study 3: Correlations between slope and size of N2 effect

Object naming



$r = -.18$

Action naming



$r = -.45^*$

Magnitude of N2 effect (μv)

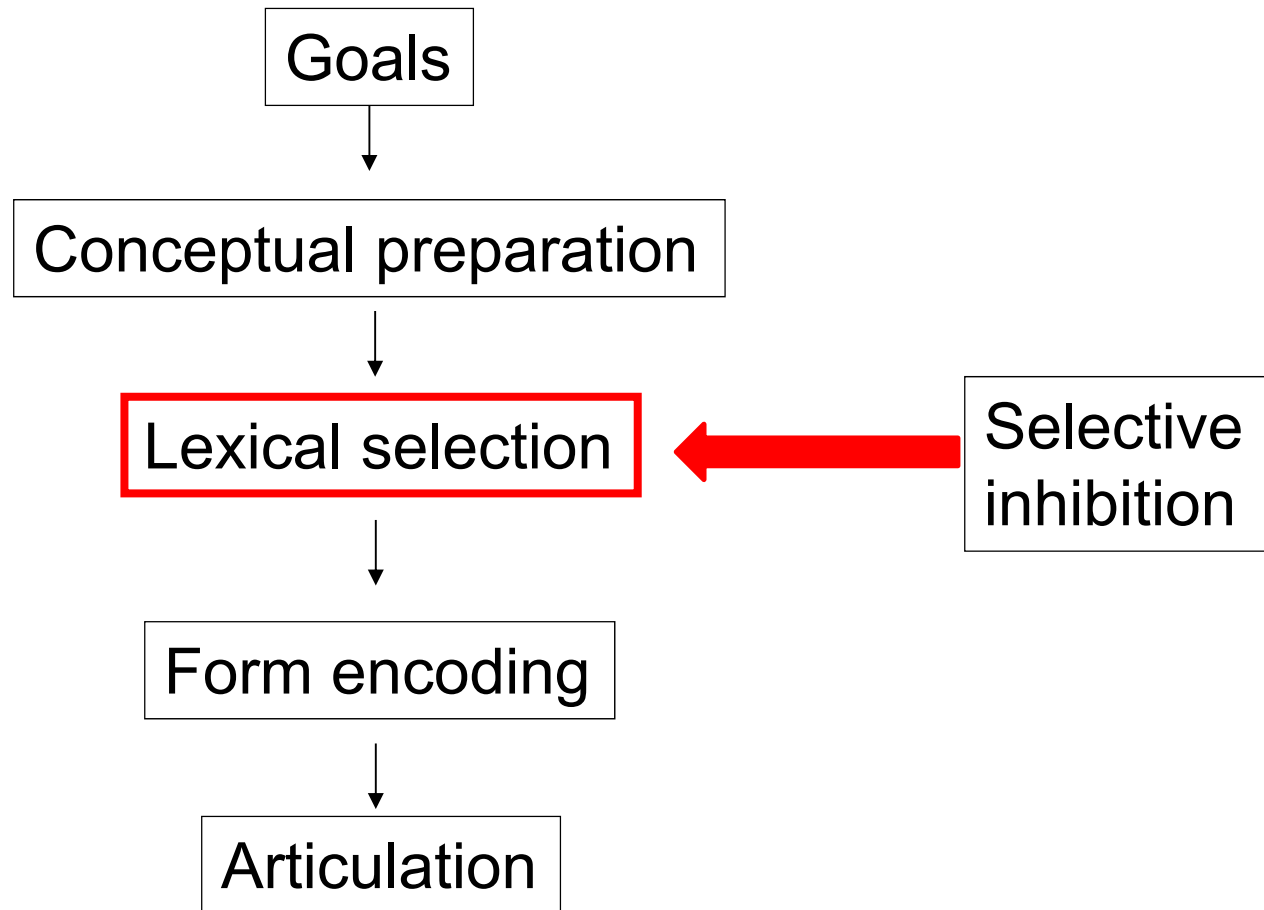
(Shao et al., Brain Research, 2014)

Study 3: Conclusions

- Longer naming RTs and more pronounced N2 in low than high NA condition.
- Slowest slope of delta plots negatively related to name agreement effect and N2 effect.
- Selective inhibition is engaged to support lexical selection during word production.

(Shao et al., Brain Research, 2014)

Conclusion



(e.g., Levelt, Roelofs, & Meyer, 1999)

Thank you!