

## Introduction

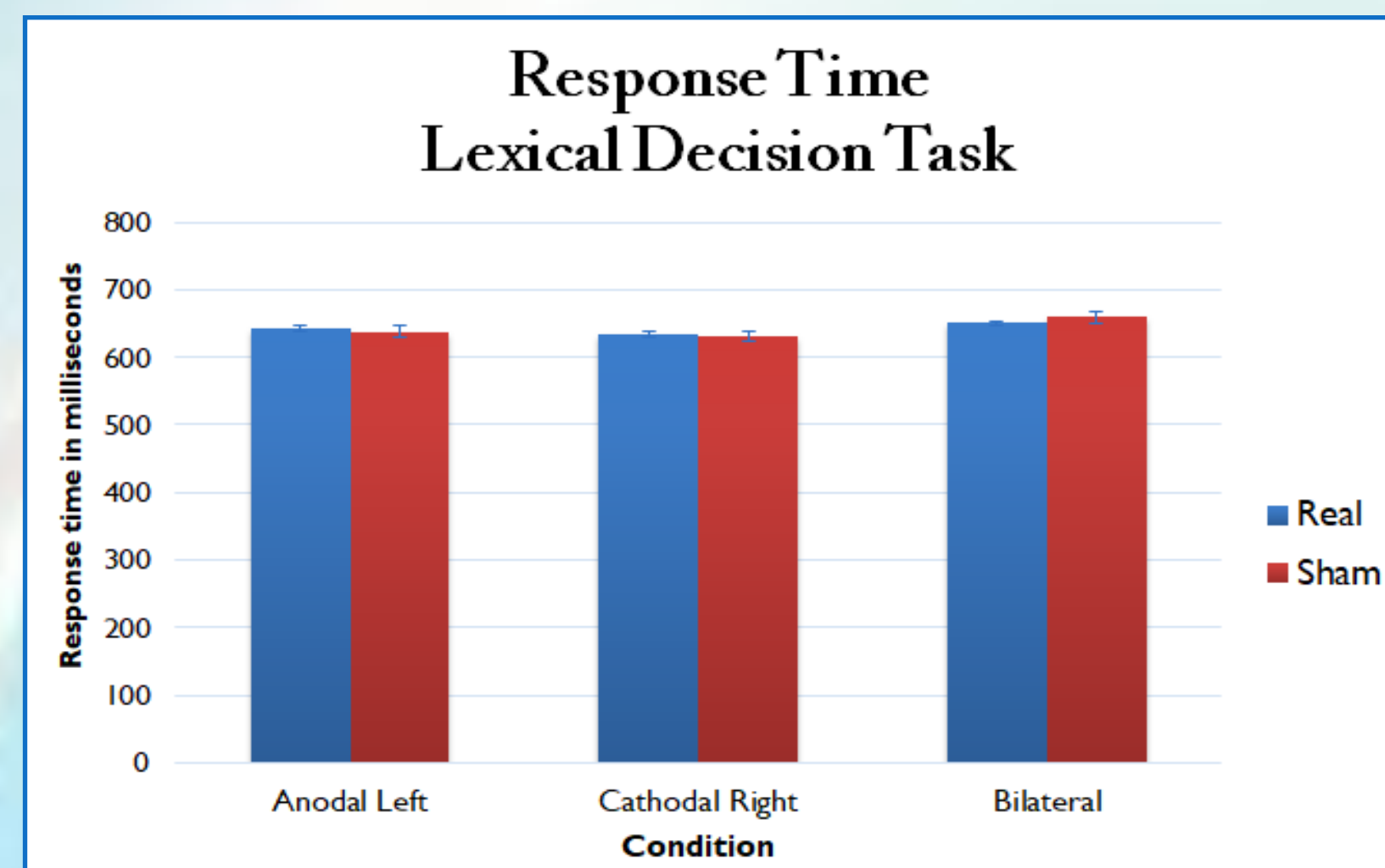
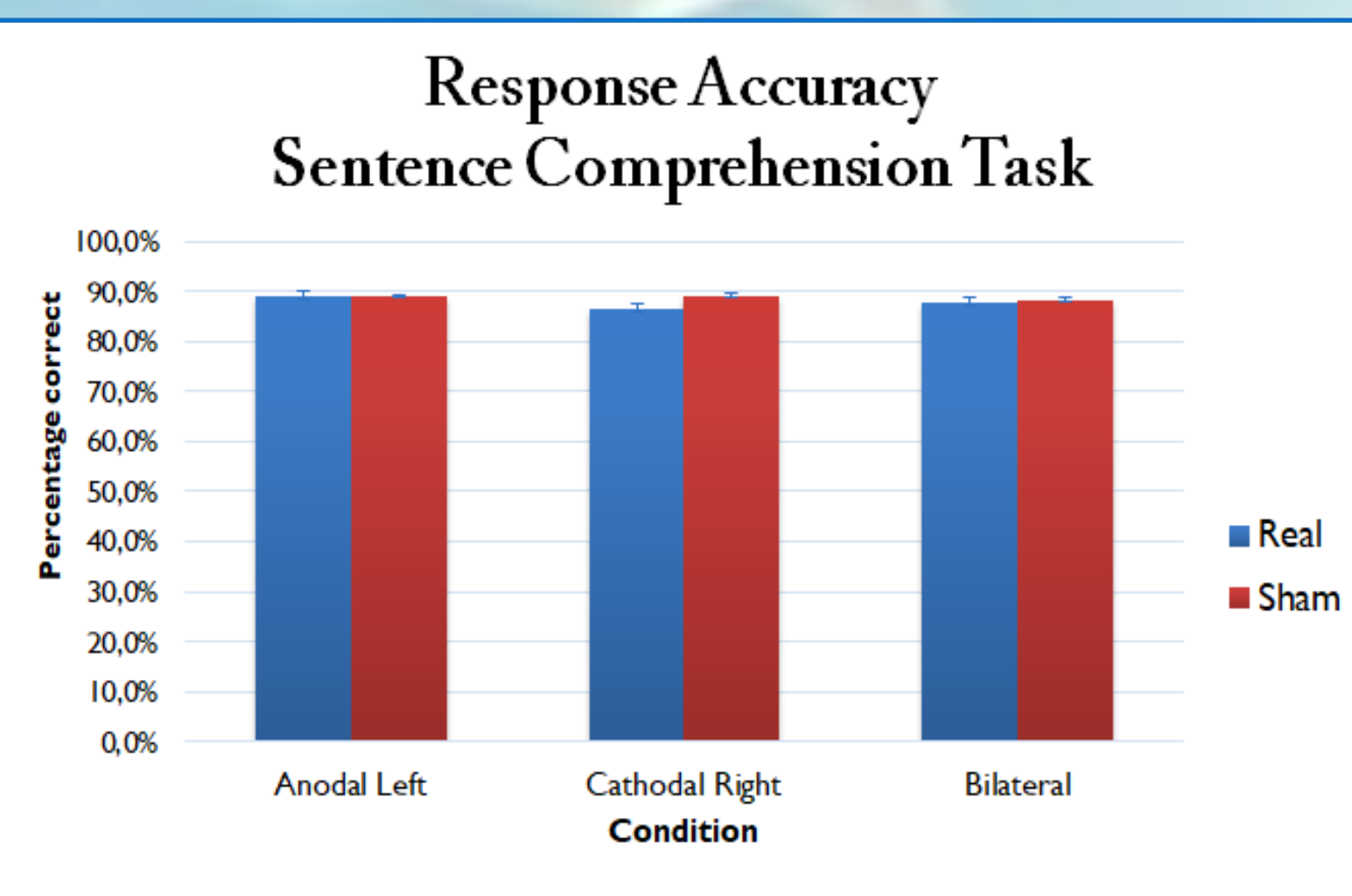
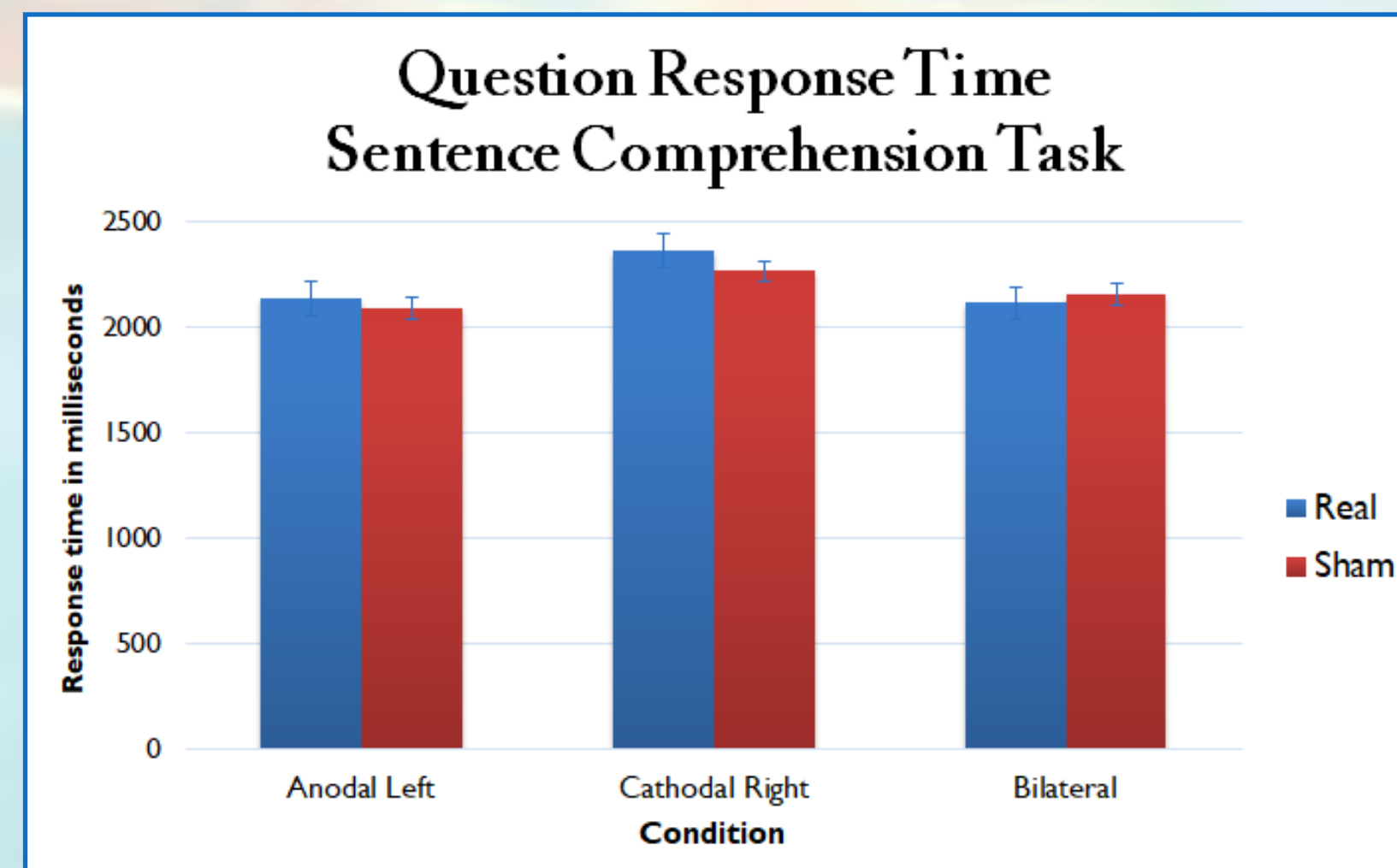
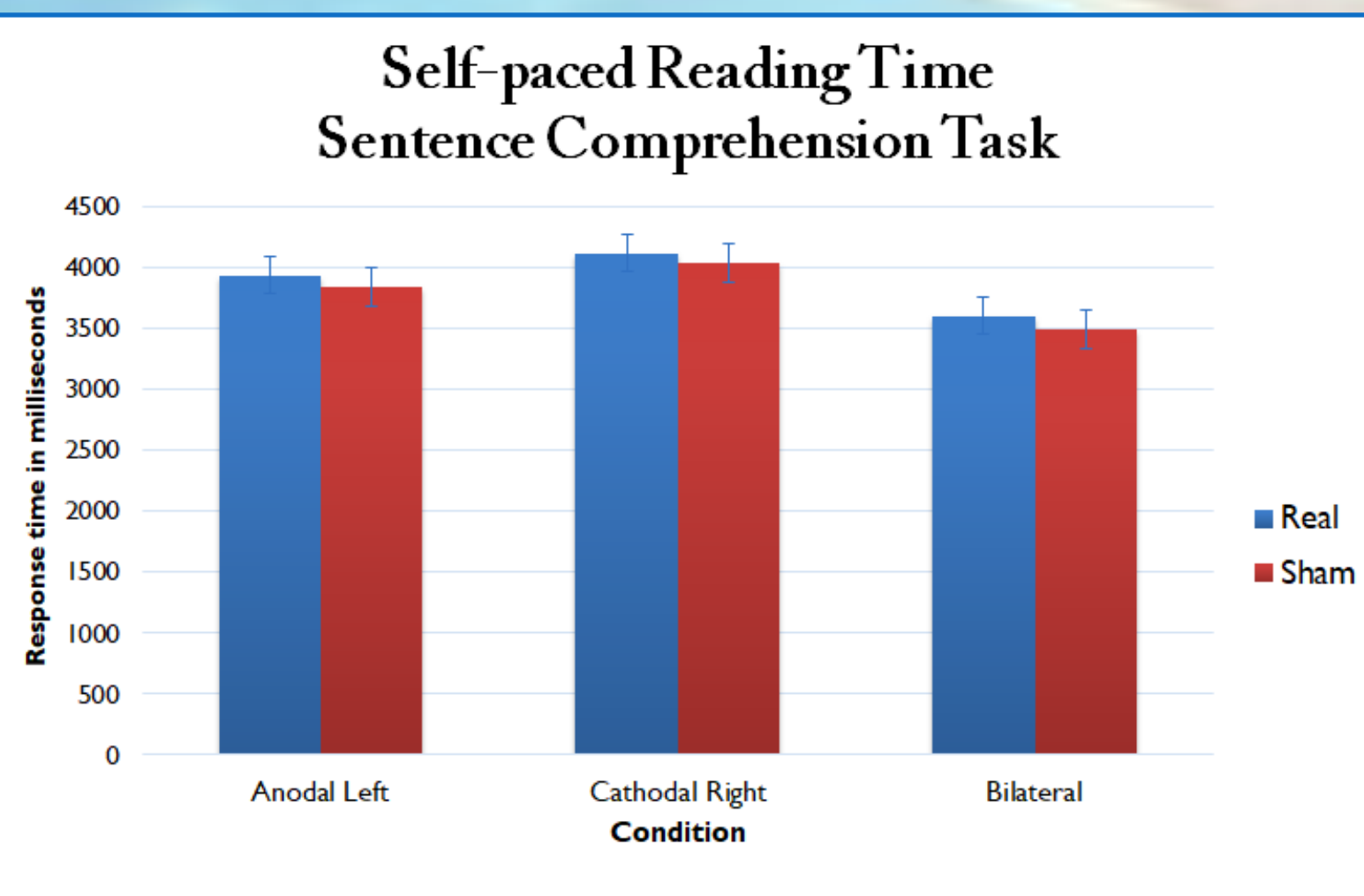
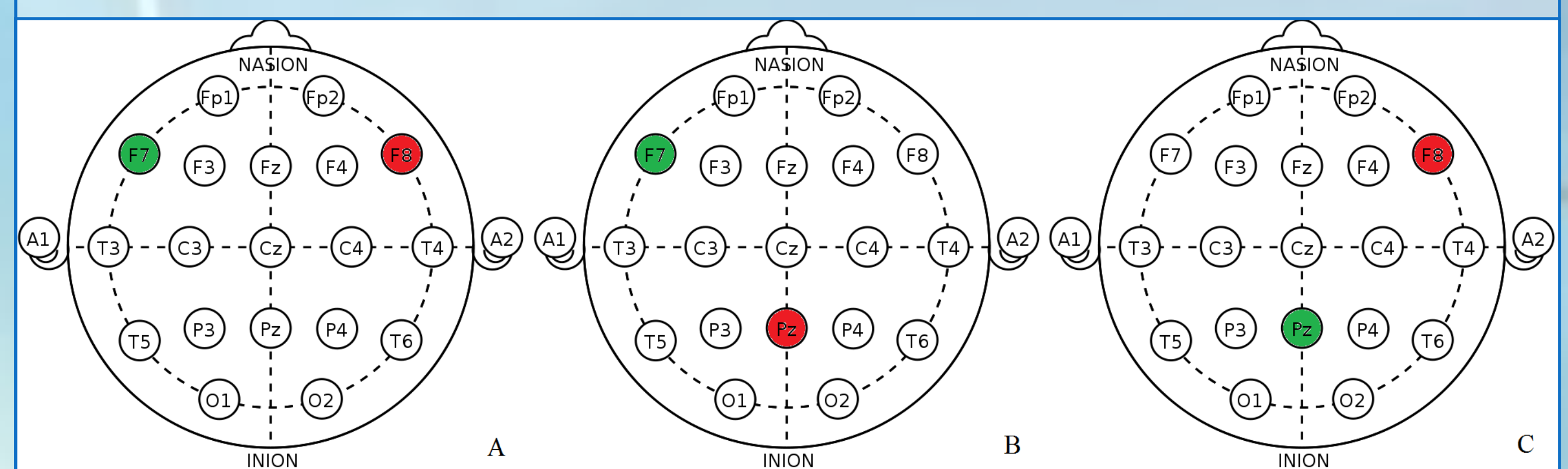
- tDCS is a **safe** and **tolerable** method.
  - There is a high potential for **clinical use** to treat patients with aphasia<sup>1</sup>.
- Which stimulation settings and targets provide the greatest therapeutic effect?
- Interhemispheric competition hypothesis:**  
In post-stroke aphasia, involvement of the right hemisphere may be **maladaptive** and **hinder recovery** via perilesional left-hemispheric activity<sup>2</sup>.
  - Many brain stimulation studies have inhibited the right hemisphere<sup>3</sup>.
  - Marangolo et al. (2016)<sup>4</sup> combined this with excitation of the left hemisphere but did not test whether the effect was superior to excitation of the left hemisphere only.

## Aim

To investigate the effects of **bilateral** tDCS in **healthy** participants, with left excitatory and right inhibitory stimulation as **control conditions**.

## Method

- 49 healthy participants (mean age 22.9, range 18-30), right-handed, native speakers of Russian, no history of neurological or psychiatric disorders, and speech or language disorders.
- Each participant was assigned to one condition:
  - Bilateral condition:** anodal stimulation to Broca's area and cathodal to the right hemisphere homologue of Broca's area (N=15).
  - Anodal stimulation** of Broca's area (F7) (N=19).
  - Cathodal stimulation** of right-hemisphere homologue of Broca's area (F8) (N=15).



- Two sessions; one with **real** stimulation (1.5 mA for 20 min.) and one with **sham** stimulation.

### Tasks:

- Lexical decision** task (120 items).
  - Sentence comprehension** task (60 items); self-paced reading with complex sentences; each followed by a comprehension question with two response options.
- 2 stimuli list for each task.
  - Lists were balanced on important **psycholing variables**.
  - The lists were **counterbalanced** across stimulation conditions.



### Statistics:

- Linear Mixed-Effect Models:** lme4 package in R; p-values obtained via the likelihood ratio test.
- Fixed factors:** Stimulation (real vs. sham), Stimulation site (left anodal vs. right cathodal vs. bihemispheric), Linguistic condition (word/non-word or sentence type), Session (day 1 or 2).

## Results

### Sentence Comprehension Task

#### Reading speed:

	Df	Sum Sq	Mean Sq	F value	p-value
Stimulation	1	1182286	1182286	1.39	0.43
Session	1	12841677	12841677	15.11	0.00
Stimulation site	2	2550198	1275099	1.50	0.23
SentenceType	4	114398308	28599577	33.66	<0.001
Stimulation*Site	2	21893	10947	0.013	0.99

#### Question accuracy:

	Df	Sum Sq	Mean Sq	F value	p-value
Stimulation	1	3.142	3.1416	3.14	0.05
Session	1	8.124	8.1239	8.12	0.00
Stimulation site	2	1.105	0.5523	0.55	0.57
SentenceType	4	53.897	13.4742	13.47	<0.001
Stimulation*Site	2	1.491	0.7456	0.75	0.15

#### Question response time:

	Df	Sum Sq	Mean Sq	F value	p-value
Stimulation	1	508529	508529	0.34	0.75
Session	1	10086634	10086634	6.75	0.016
Stimulation site	2	1179193	589597	0.39	0.68
SentenceType	4	156428925	39107231	26.17	<0.001
Stimulation*Site	2	4972618	2486309	1.66	0.20

### Lexical Decision

#### Response time:

	Df	Sum Sq	Mean Sq	F value	p-value
Stimulation	1	1182286	1182286	1.39	0.43
Session	1	12841677	12841677	15.11	0.00
Stimulation site	2	2550198	1275099	1.50	0.23
SentenceType	4	114398308	28599577	33.66	<0.001
Stimulation*Site	2	21893	10947	0.013	0.99

#### Lexical decision accuracy:

At ceiling; 97-98% across all conditions.

## Discussion

- What are the effects of **bilateral tDCS** in healthy participants compared to the two **control conditions**; left anodal stimulation and right cathodal stimulation?
- No improvement** in reading time on the sentence comprehension task and in response time and accuracy on the sentence comprehension task and lexical decision task.
- No support for the **interhemispheric competition hypothesis** or for beneficial effects of tDCS overall.
- Stimulation parameters; sensitivity of tasks.
- Underlying **neuronal mechanisms** not yet fully understood.
- tDCS effects overrated due to publication bias?
- Is tDCS effective in patients with aphasia who have a disturbed language network?

## References

- Galletta E. E., Conner P., Vogel-Eyny A., Marangolo P. (2016). Use of tDCS in Aphasia Rehabilitation: A Systematic Review of the Behavioral Interventions Implemented With Noninvasive Brain Stimulation for Language Recovery. *American Journal of Speech-Language Pathology*, 25, S854-S867.
- Cocquyt E.-M., De Ley L., Santens P., Van Borsel J., De Letter M. (2017). The role of the right hemisphere in the recovery of stroke-related aphasia: A systematic review. *Journal of Neurolinguistics*, 44, 68-90.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4412051/>
- Marangolo P., Fiori V., Sabatini U., De Pasquale G., Razzano C., Caltagirone C., Gili T. (2016). Bilateral Transcranial Direct Current Stimulation Language Treatment Enhances Functional Connectivity in the Left Hemisphere: Preliminary Data From Aphasia. *Journal of Cognitive Neuroscience*, 28(5), 724-738.