Investigating word recognition with Fast Periodic Visual Stimulation (FPVS) using electroencephalography (EEG)

ARC CENTRE OF EXCELLENCE IN COGNITION AND ITS DISORDERS

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Introduction

Distinguishing words (e.g., *smile*) from pseudowords (e.g., *smiel*) is a crucial skill of **visual word recognition**. How the brain allows us to make this distinction is yet unknown, with **neural responses** that differentiate words and pseudowords often found **elusive** in standard fMRI, MEG, and EEG paradigms using standard tasks like lexical decision.

Lochy et al. (2015) reported a neural contrast between French words and pseudowords in a study that combined two methods:

- **Fast Periodic Visual Stimulation (FPVS)**: Presentation of a rapid stream of stimuli with intermittent oddball stimuli. Subjects are not required to make a response to the stimuli.
- **Electroencephalography (EEG)**: Provides a continuous measure of electrical potentials generated by brain cells

Our Study

Can we **replicate** Lochy et al.'s finding and find a neural marker for visual word recognition in English?

Stimuli

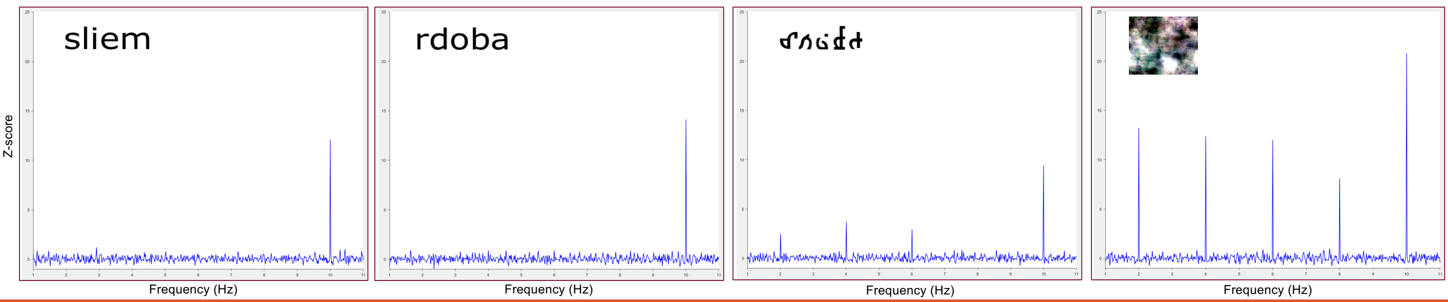
- 3 lexical conditions (named as <Oddball> in <Base>):
  - **Words in Pseudowords** (e.g., *smile* in *sliem*)
  - **Words in Nonwords** (e.g., *smile* in *rdoba*)
  - **Words in False fonts** (e.g., *smile* in)
- Control condition (named as <Oddball> in <Base>):
  - **Natural faces in Phase-scrambled faces**
- 30 stimuli for each type (repeated 4 times per trial)
- Lexical characteristics calculated by MC-Word

Procedure

- 20 right-handed undergraduate MQ students
- EEG: 32-channel Neuroscan set-up
- FPVS:
  - Trial starts with a fixation cross
  - 60 second rapid presentation of stimuli (100ms/stimulus)
  - Every 5th item in the stream is the "oddball" stimulus
  - Task: Press a key when the fixation cross changes colour
- Four trials per condition (total test time of **16 minutes**)

Results – Z-scores for frequencies of interest in electrode O1. Oddball response @ 2Hz; Base response @ 10Hz

Words in Pseudowords | **Words in Nonwords** | **Words in False fonts** | **Faces in Scrambled faces**



Results – Z-scores for frequencies of interest in electrode O1. (Italics: Lochy et al. results)

	2Hz (oddball)	10Hz (base)	Replicated?
Words in PW	0.51 *(3.15*)*	12.10* *(32.89*)*	✗
Words in NW	0.37 *(3.54*)*	14.13* *(34.94*)*	✗
Words in FF	2.70* *(14.67*)*	10.15* *(35.20*)*	✓
Faces in SF	13.24*	20.81*	NA

*z > 1.96, p < .05

Conclusions

- Key findings:
  - Significant base response in all conditions
  - Significant oddball response **only** in the false fonts condition and the control (faces) condition
- **Unsuccessful in replicating** Lochy et al.'s finding of a neural marker for visual word recognition

Future directions

- Follow-up study in which presentation parameters are more closely matched to Lochy et al.'s study
- Validate the FPVS paradigm with the Emotiv EPOC+ to potentially shorten testing time even more
- What does all of this mean?
  - Could word meaning not be activated automatically and perhaps be task-dependent?
  - Could the oddball effect reflect a process other than activation?

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