

Pupil response as a processing measure of morphologically (pseudo) complex words Yoichi Mukai, Juhani Järvikivi, Benjamin V. Tucker, and Kaidi Lõo

1. Introduction

Pupil dilation has been shown to reflect the cognitive load of speech processing based on factors such as:

- Intelligibility (e.g., Zekveld et al., 2013)
- Modality (Klingner et al., 2011)
- Word frequency (e.g., Kuchinke et al., 2007)

Research objective:

Using visual and auditory modalities, this study examines the time course of the processing of morphologically complex and pseudo complex words, with a focus on interactions between stem and word frequency effects.

2. Method

42 native speakers of North American English

159 morphologically complex (pseudo) words

- Transparent words (e.g., cleaner)
- Opaque words (e.g., corner)
- Form words (e.g., turnip)

Task:

Participants completed both visual and auditory lexical decision tasks

Data processing:

Downsampled to 50Hz, cleaned blinks and their artifacts, baseline normalized pupil dilation (200 ms preceding)

Analysis:

Generalized Additive Mixed-effects Modeling (Wood, 2006)

Response variables: Baselined Pupil Dilation (200 - 2000 ms)

Input variables: Word Type, Modality, Log transformed Frequency (Word, Stem), Trial, Pupil coordinates (X and Y), Time, Recording session, Event (Trail + Recording session)

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3. Results

Audio vs. Visual modality:

Latencies of dilation peaks differ but magnitude of dilation peaks do not differ across the word types (Fig.1,2 and 3)

Word Types in Visual modality:

Transparent words show an earlier dilation peak as compared to the other two words (Fig. 1 and 4)

Word Types in Audio modality:

Form words show an earlier dilation peak as compared to the other two words (Fig. 2 and

Stem and Word frequency interaction: Visual in Form words: Pupil dilates more as stem frequency goes up when word frequency is high. Pupil dilates more as stem frequency goes down when word frequency is low (Fig.

Visual in Opaque words: Pupil dilates more as stem frequency goes down when word frequency is high. Pupil dilates more as stem frequency goes up when word frequency is low (Fig. 7)

Auditory in Transparent words: Pupil dilates more as stem frequency goes up when word frequency is either low or high (Fig. 8)

4. Conclusions

Pupil dilations indicate the modality difference in the latencies of dilation peaks

Stem frequency effects in Form and Opaque words in the visual domain suggest that semantically blind morphological

decomposition occurs (Rastle & Davis, 2008) Stem frequency effects in Transparent words in the auditory domain suggest the activation of embedded words and their competition with a target word (Norris, 1994)

Complex interactions between stem and word frequency effects in both visual and auditory domains

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