N300 and P300 Responses are Associated with Reading Ability in Children

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Introduction

- Reading Disability (RD) is defined as unexpected difficulty in word reading and spelling despite adequate cognitive resources (Lyon et al. 2003). Approximately 10% of children worldwide are thought to have RD (Pugh et al. 2013).

- The N300 is an Event Related Potential (ERP) that is associated with the integration of orthographic and phonological representations (Hasko et al. 2012), a skill known to be impaired in RD.

- The P300 component has been shown to index attention, working memory, and categorization (Duncan et al. 2009), all of which have been implicated in RD.

- **Research Question**: Can we identify variation in the neural response (P300 and N300) as a function of reading ability?

Methods: Behavioral

Participants: Children: N = 33; 19 male; M age = 8.98 (SD = 1.56)

Assessments

Woodcock Johnson III Tests of Achievement:
Letter-Word Identification, *Spelling*
**Test of Word Reading Efficiency (TOWRE)**:
Phonemic Decoding Efficiency

- Standard scores were used to generate a composite Reading Average score. Scores were normally distributed, and the lowest quartile was defined as Reading Disabled (RD, N=10, Reading Average < 90).
- Subjects had a WASI Full-4 IQ > 80

Methods : ERP Picture Identification

Following presentation of a picture, one of four types of stimuli were shown on screen:
- Word, Match (e.g., rose)
- Word, non-Match (e.g., rope)
- Pseudowords (e.g., rolt)
- Consonant Strings (e.g., rfks)

1000 ms
2000 ms
3000 ms
rolt
rose
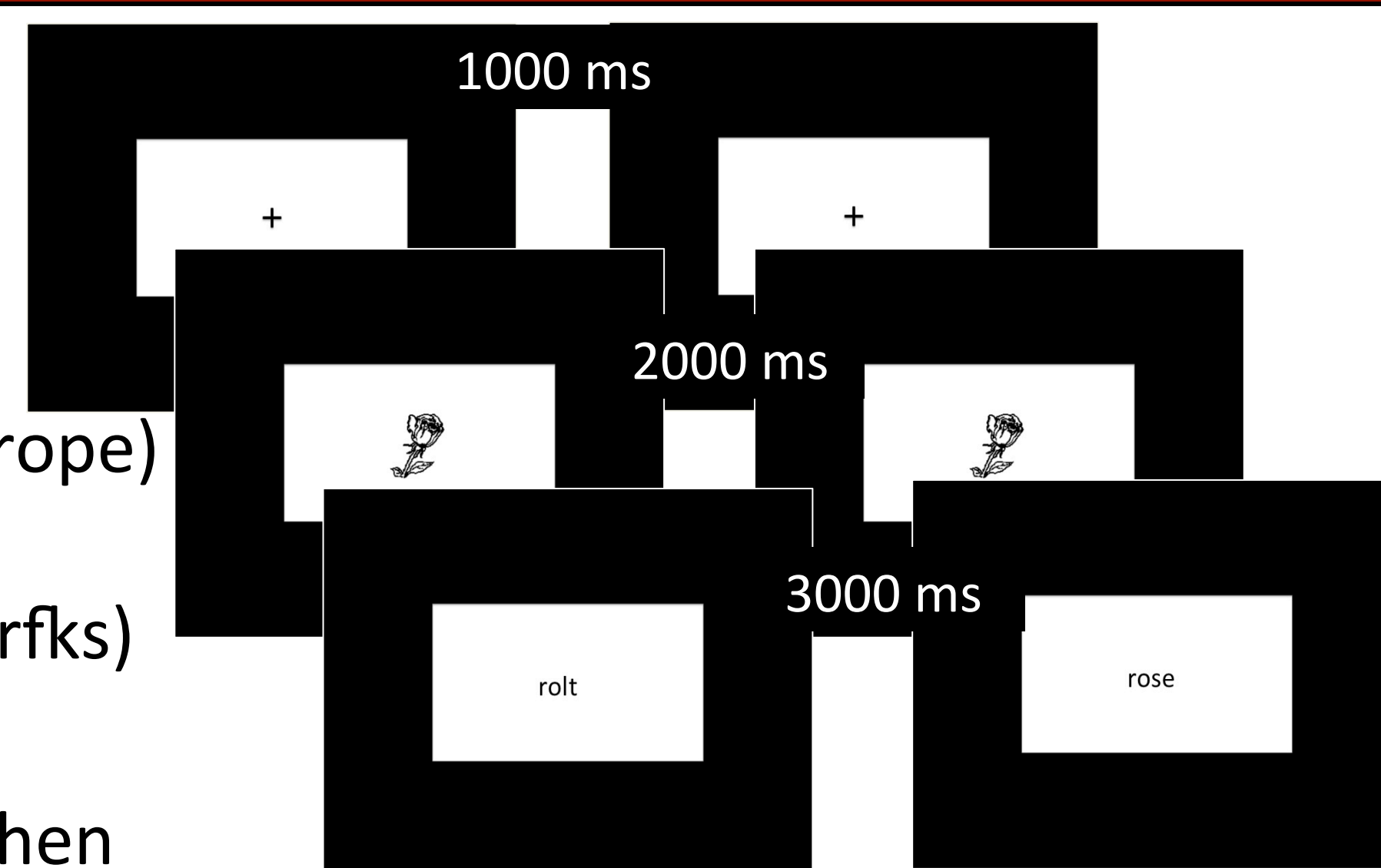
Participants pressed a button when the word matched the picture.

ERP Data Processing & Analysis
Collection: EEG was recorded using 128-channel HydroCel GSN electrode net and an EGI Net Amps 300 amplifier with a sampling rate of 500 hz.
Processing: .3-30Hz Bandpass filter, segmented into -100ms - 600ms epochs, manual, and semi-automated routines were used for artifact detection and bad channel replacement.

Results

N300

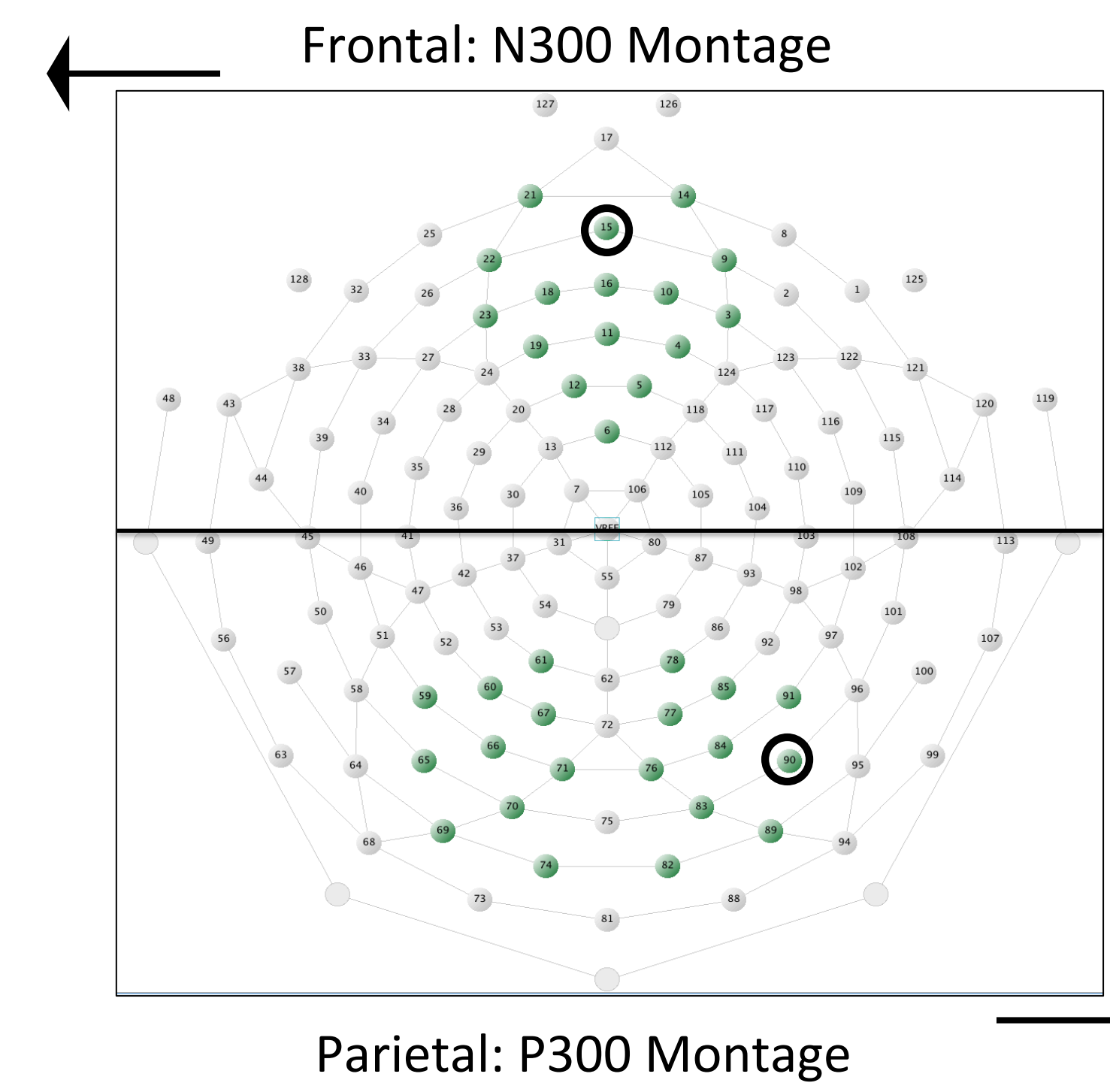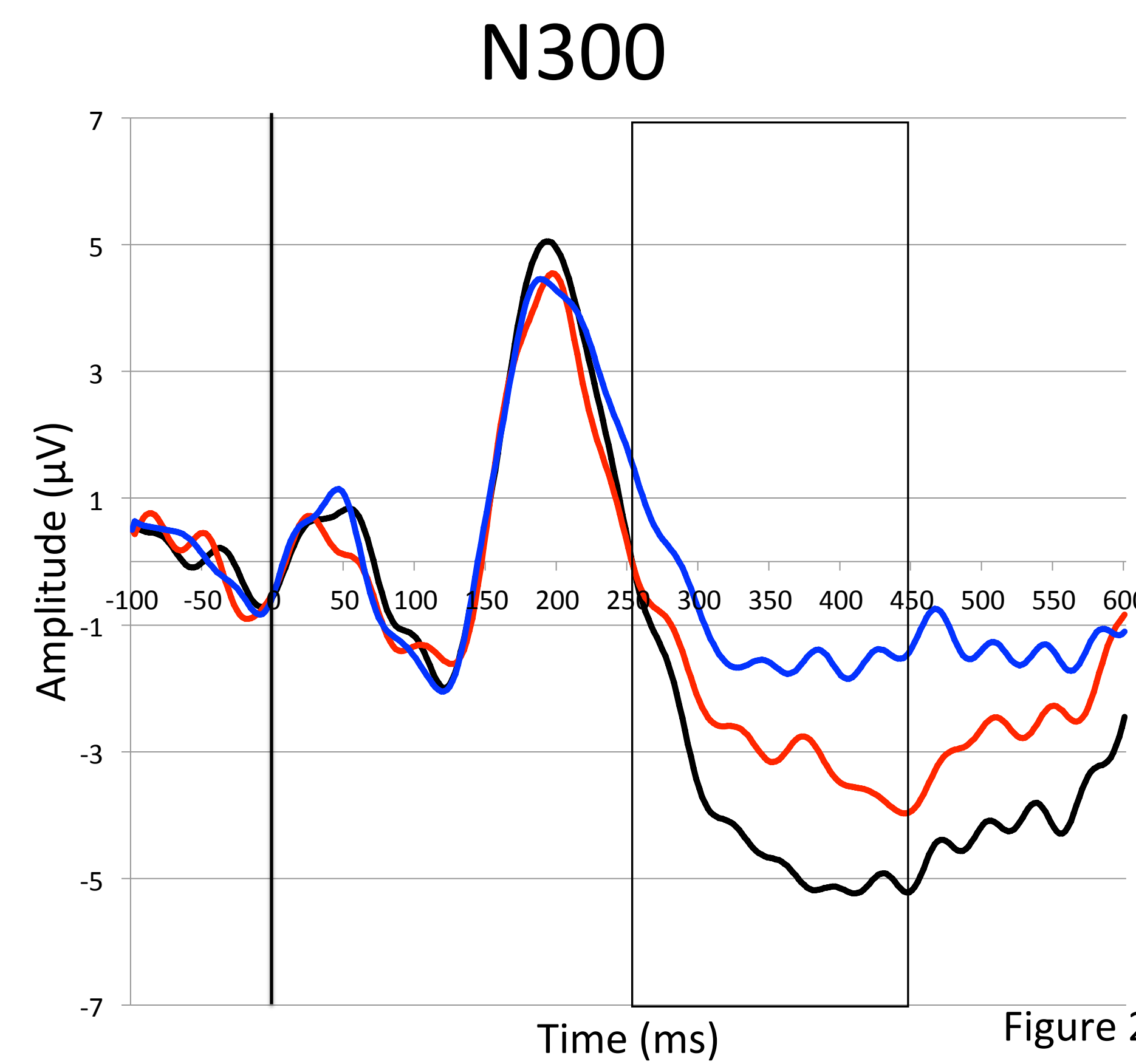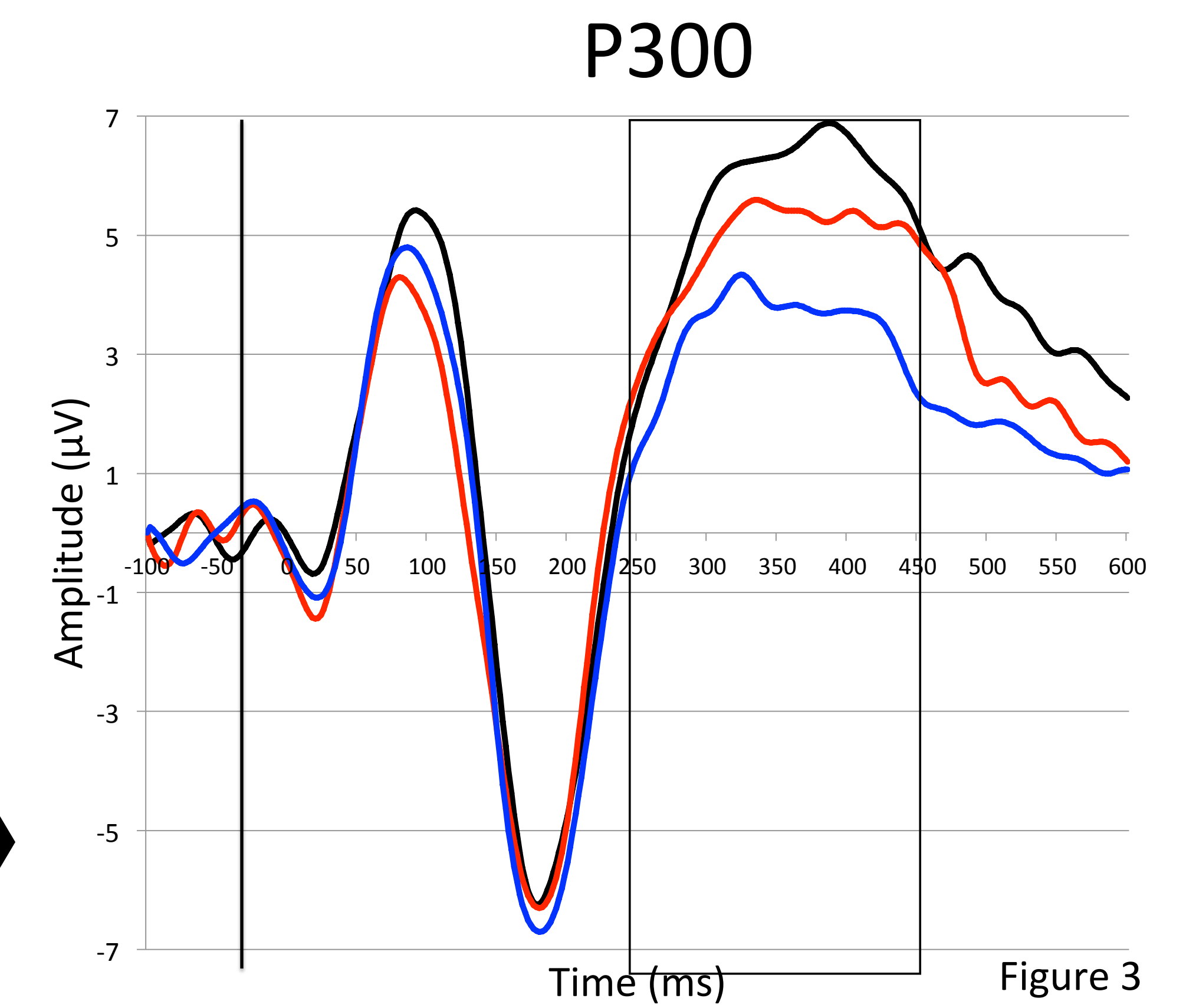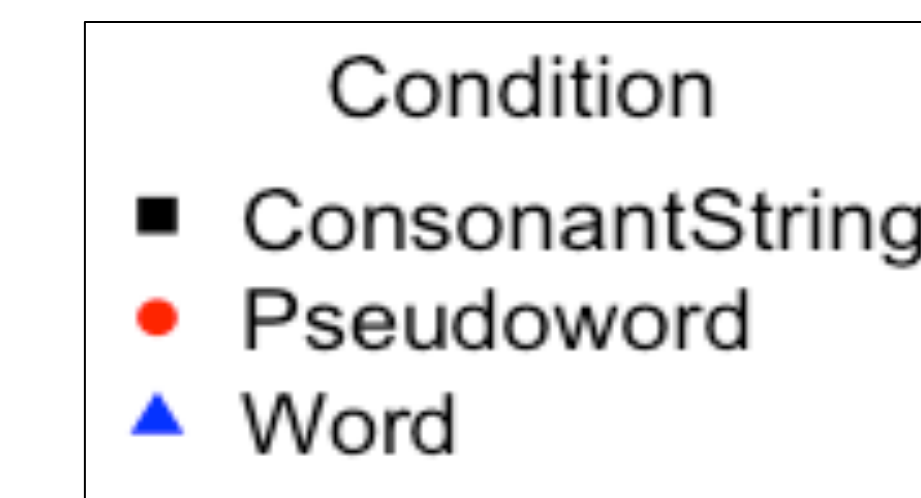### P300

Frontal: N300 Montage

Parietal: P300 Montage

Figure 1: Electrode clusters used in analysis, exemplar electrodes are circled.

Figures 2 & 3: Grand Averaged waveforms of P300 and N300. Analyzed time window is boxed: 250-350ms.

Condition
- ■ ConsonantString
- ● Pseudoword
- ▲ Word

A linear model was calculated to predict Amplitude for each Condition (within subjects) based on Reading Average (between subjects). It showed a significant interaction between **Reading Average score** and **Amplitude by Condition** $F(5, 87)=2.566$, $p<.05$, $\eta_p^2=.129$, such that N300 amplitude to **words,** but not to consonant strings or **pseudowords,** was negatively associated with reading skill.
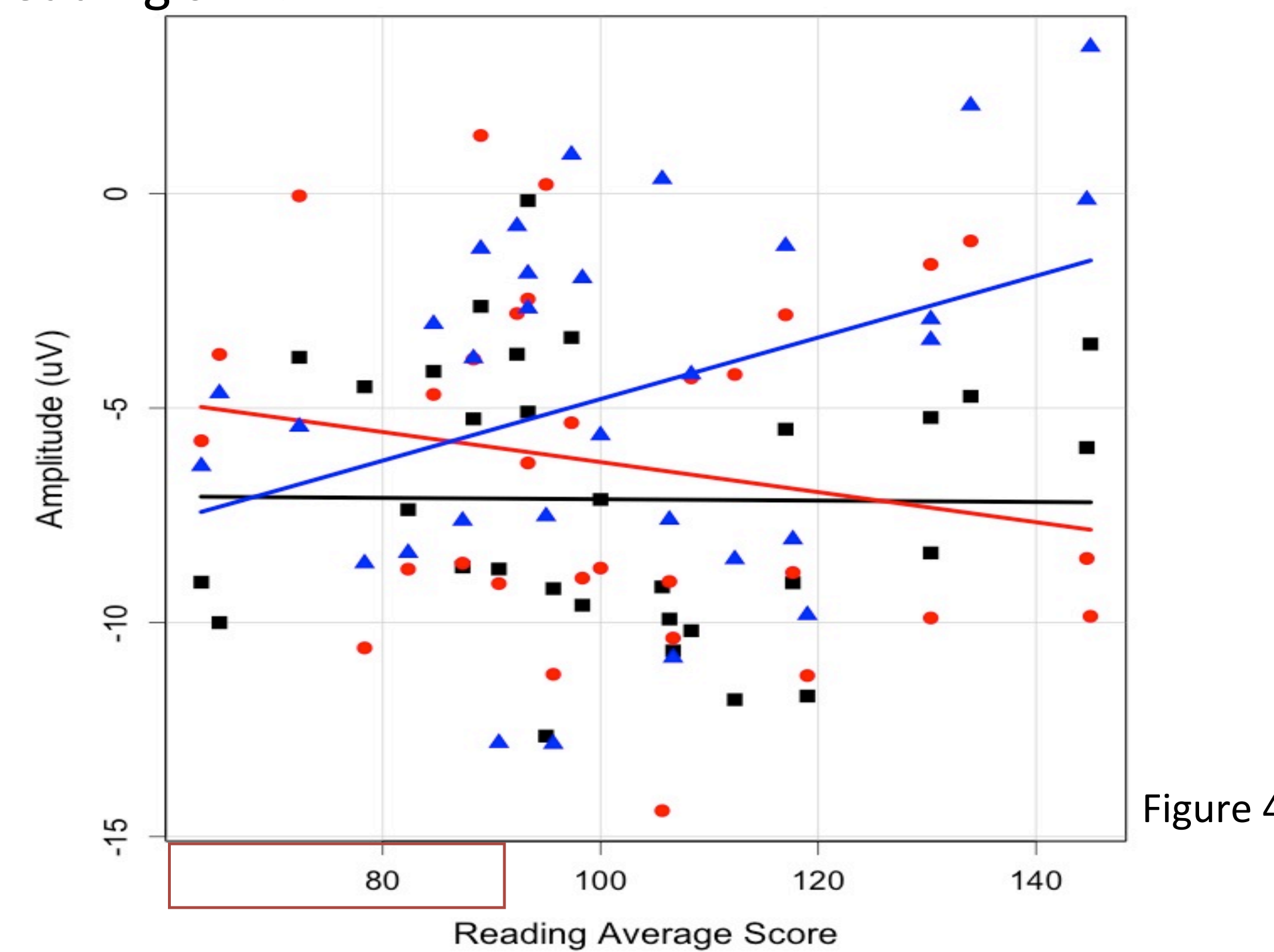
A separate linear model was calculated to predict Amplitude for each Condition (within subjects) based on Reading Average (between subjects). It showed a significant interaction between **Reading Average score** and **Amplitude by Condition** $F(5, 87)=1.756$, $p<.05$, $\eta_p^2=.092$, such that P300 amplitudes to **words,** but not to consonant strings or **pseudowords,** were negatively associated with reading skill.
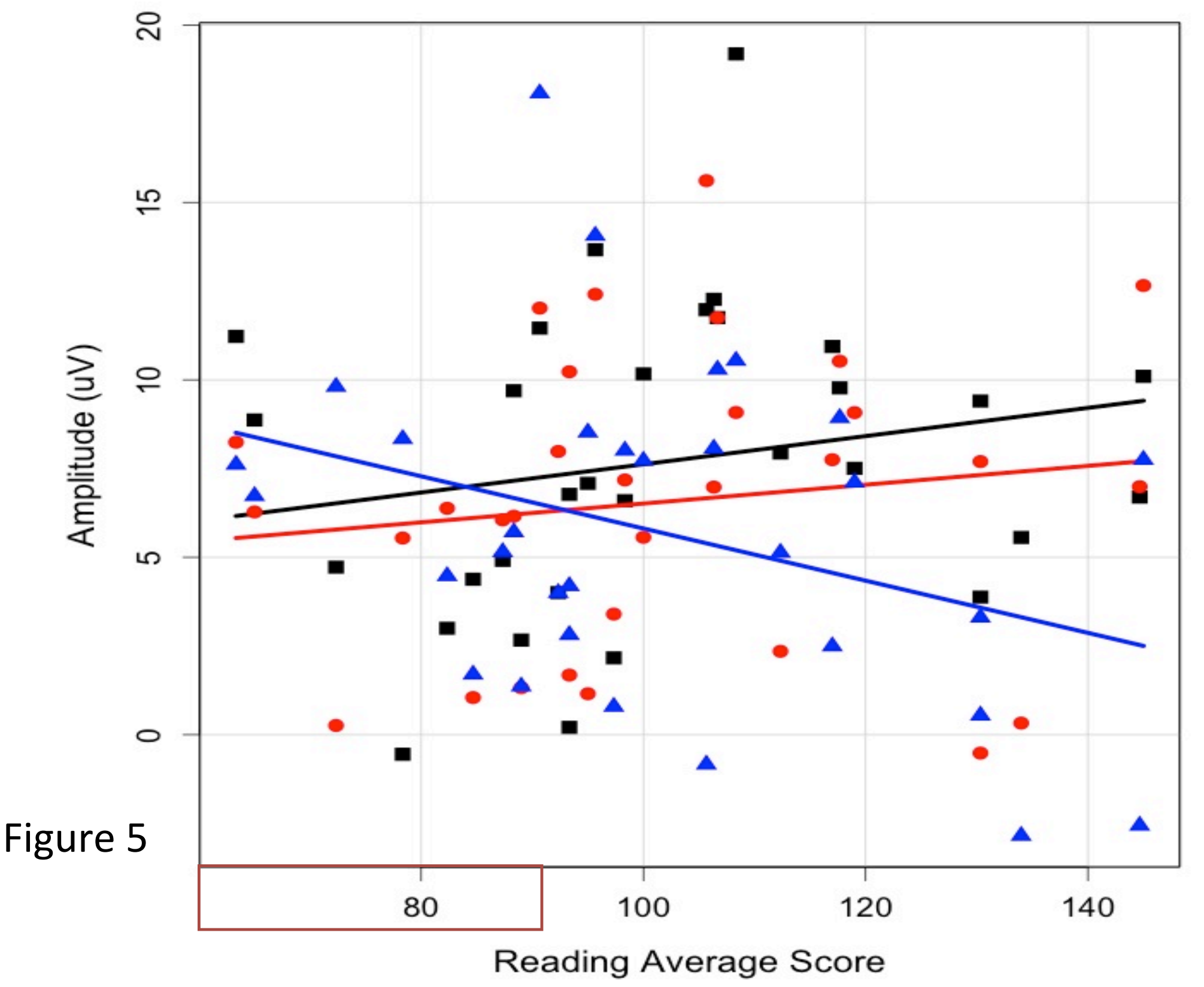
Figures 4 & 5: Amplitudes of N300 and P300 by Reading Average. RD categorizations are boxed on X axis.

Conclusion

Reduced N300 and P300 in better readers may suggest improved integration of orthographic and phonological information, and generally better allotting of attentional resources.

References

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