N400 RESPONSES IN INDIVIDUALS WITH NORMAL HEARING WITH AND WITHOUT LISTENING CONCERNS

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Overview

1) Background

➤ Factors that influence speech comprehension

➤ N400 and it's significance

2) Aim and hypothesis

3) Method

➤ Participant candidacy

➤ Stimuli

4) Results

5) Discussion

Communication: Two-way process b/w the listener & the speaker majorly involving the perception of auditory information

<div align="right">(Rice-Johnston, W. 2008; Pichora-Fuller, Singh 2006)</div>

Successful communication: Requires accurate perception and comprehension of the incoming signal

<div align="right">(Pichora-Fuller, 2003)</div>

Factors that previous literature found to influence speech comprehension

Auditory

➤ Perception of sound affected➔ presence of hearing loss

(Abel, Krever, & Alberti, 1990)

➤ Comprehension ➔ affected despite normal percept of sound (as evaluated clinically)

(Kumar, Ameenudin, & Sangamanatha, 2012)

Cognitive

➤ Attention

(Pichora-Fuller, 2003)

➤ Memory

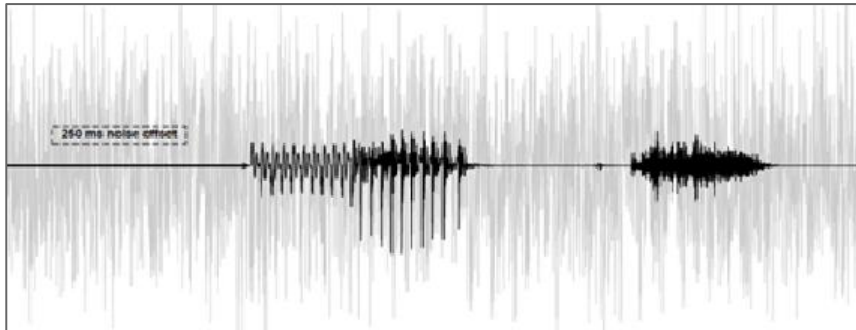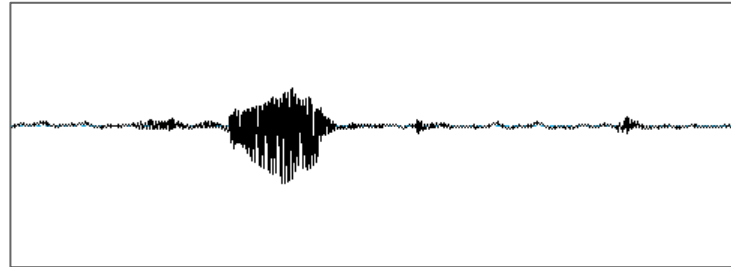(Caplan, Waters, 2005; Rönnberg et al., 2010)

Linguistic

➤ Lack of language proficiency

(Goh, 2000)

Why is it important?

Signal

Signal + Noise

What is N400?

➢ Event related potential → study speech understanding

➢ Negative deflection→ presented with semantically incongruent sentences

➢ Occurs approximately 400 ms after in-congruency onset

(Kutas&Hillyard, 1980; Ousterhout & Houlcomb 1995)

Why is N400 important?

➢ It is a measure of speech understanding

➢ Objective measure

(Kutas & Hillyard, 1988)

Current evidence: N400

➢ Used to study listening performance in individuals with schizophrenia   (Koyoma et al., 1990)

➢ Genetic pre-disposition of alcohol (Schnidt & Neville, 1985)

➢ To monitor treatment changes such as repetitive transcranial magnetic stimulation and speech language therapy intervention (Barwood eta al., 2010; Wilson et al., 2012)

➢ Auditory processing in congenitally blind and sighted people (Roder et al., 2009)

N400-Recording sites

Studies have shown occurrence of N400 mostly in the frontal, central areas (Koyoma et al., 1990; Kuperman et al.,1995;Tamara et al 2002; Roder et al., 2009)

Example: N400

Auditory sentence

N400

Central midline

——— Congruent

------- Incongruent

Van Petten et al., 1999

Why listening concern & N400?

➢ No studies have been done so far to explore speech understanding in individuals with listening concern

➢ Objective measure to assess speech understanding

Aim

To evaluate the efficiency of the N400 ERP as a potential objective indicator of speech understanding problems

Hypothesis

Individuals with listening concerns may have a reduced N400 in quiet, more pronounced in noise condition

Participant Candidacy

Participants:

age range of 18 to 70 years were recruited

Screening tests:

1) Montreal Cognitive Assessment (MoCA)

2) Pure-tone audiometry

Study population:
1) Individuals with reported listening concerns and normal hearing

➢ 640 sentences with a reasonable amount of complexity, homogeneity and sentence length *[320 congruent and incongruent]*

➢ Chosen based on a survey that was given to native English speakers

➢ Each sentence was rated based on a scale of 1 to 6

➢ For example: "the uncle spills the **tiger** from the mug" indicates a meaningless sentence. " The pilots judge the **distance** from the map" indicates a meaningful sentence

Sentence structure

➢ The + [2 syllables substantive] + [monosyllable verb] + the + [Keyword: 2 syllables substantive starting with occlusive consonant – e.g. d, t, p, k, etc. (we avoided vowels and 'w', 'y', etc. to facilitate splitting)] + [3 syllables ending]

➢ Sentences were presented in a randomised order

➢ The test also consisted of questions and fillers

➢ Test was carried out in two scenarios Quiet and Noise (8dB SNR)

➢ The Noise stimuli was later removed from testing

Task

To focus on the sentences presented & respond to only the questions asked in between the test

N400 Analysis

N400 magnitude was estimated as the area under the curve between the ERPs elicited by incongruent and congruent sentences in the time frame [0.4-0.8] seconds following the onset of the critical word
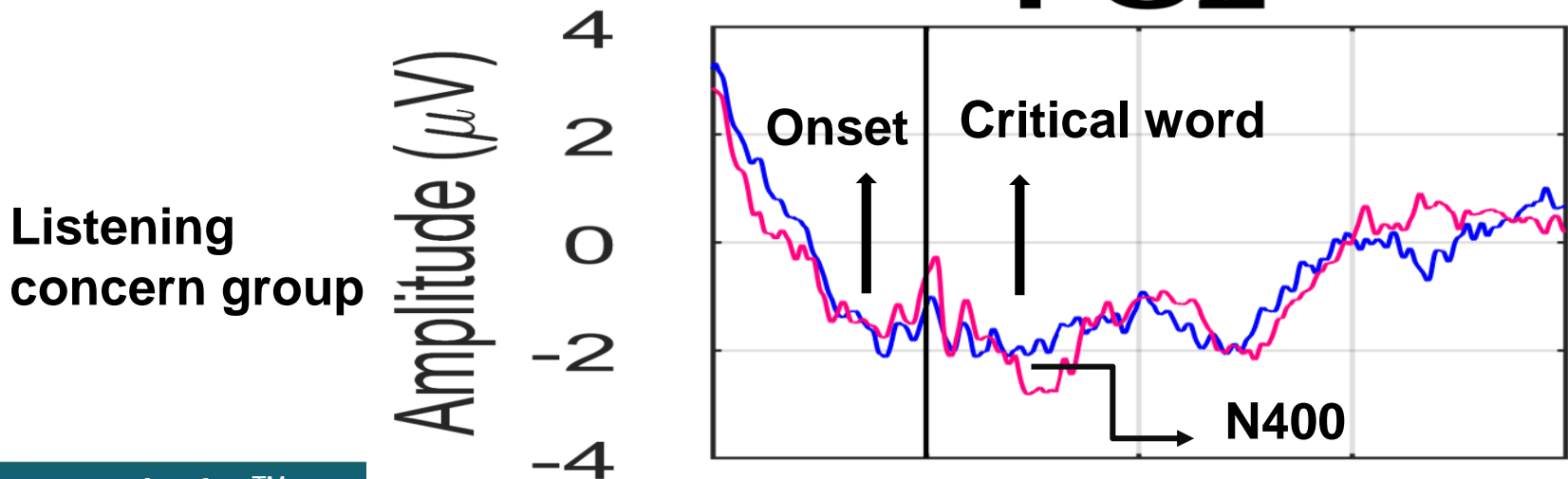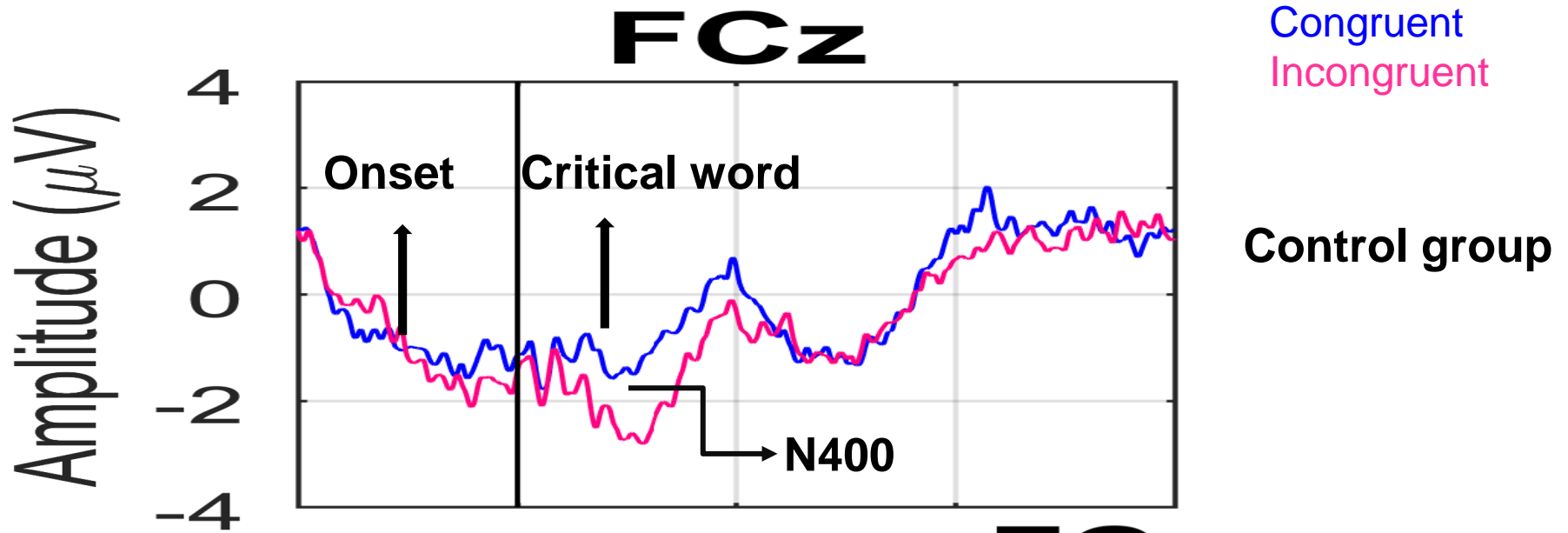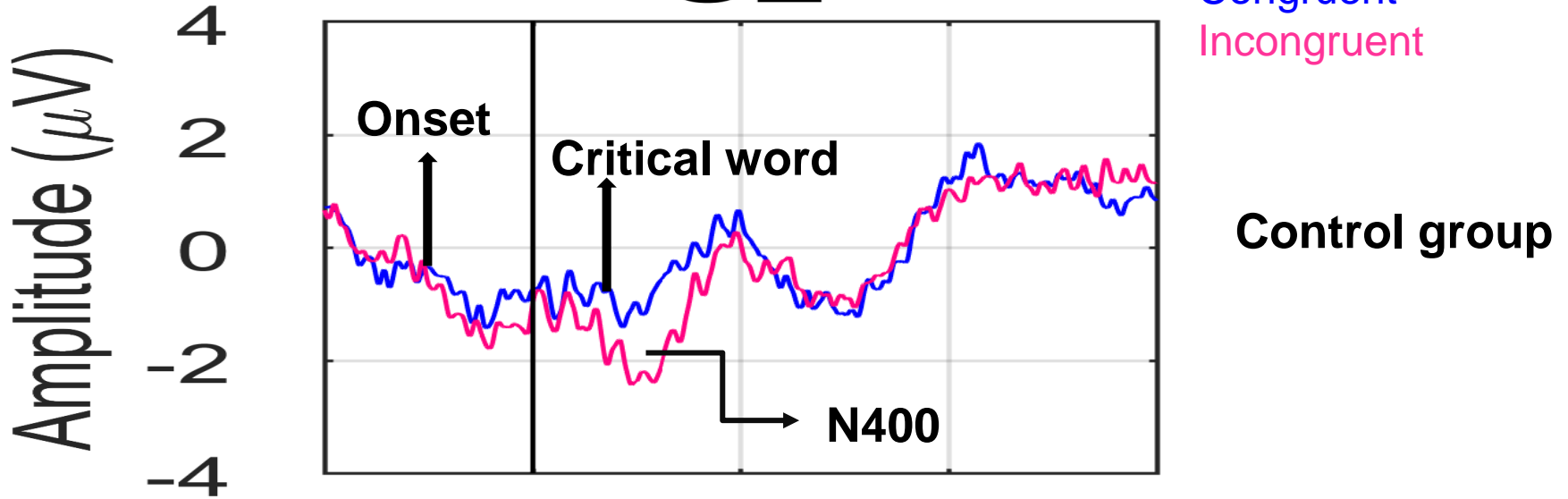
Results

CRITICAL WORD - Grand-Average
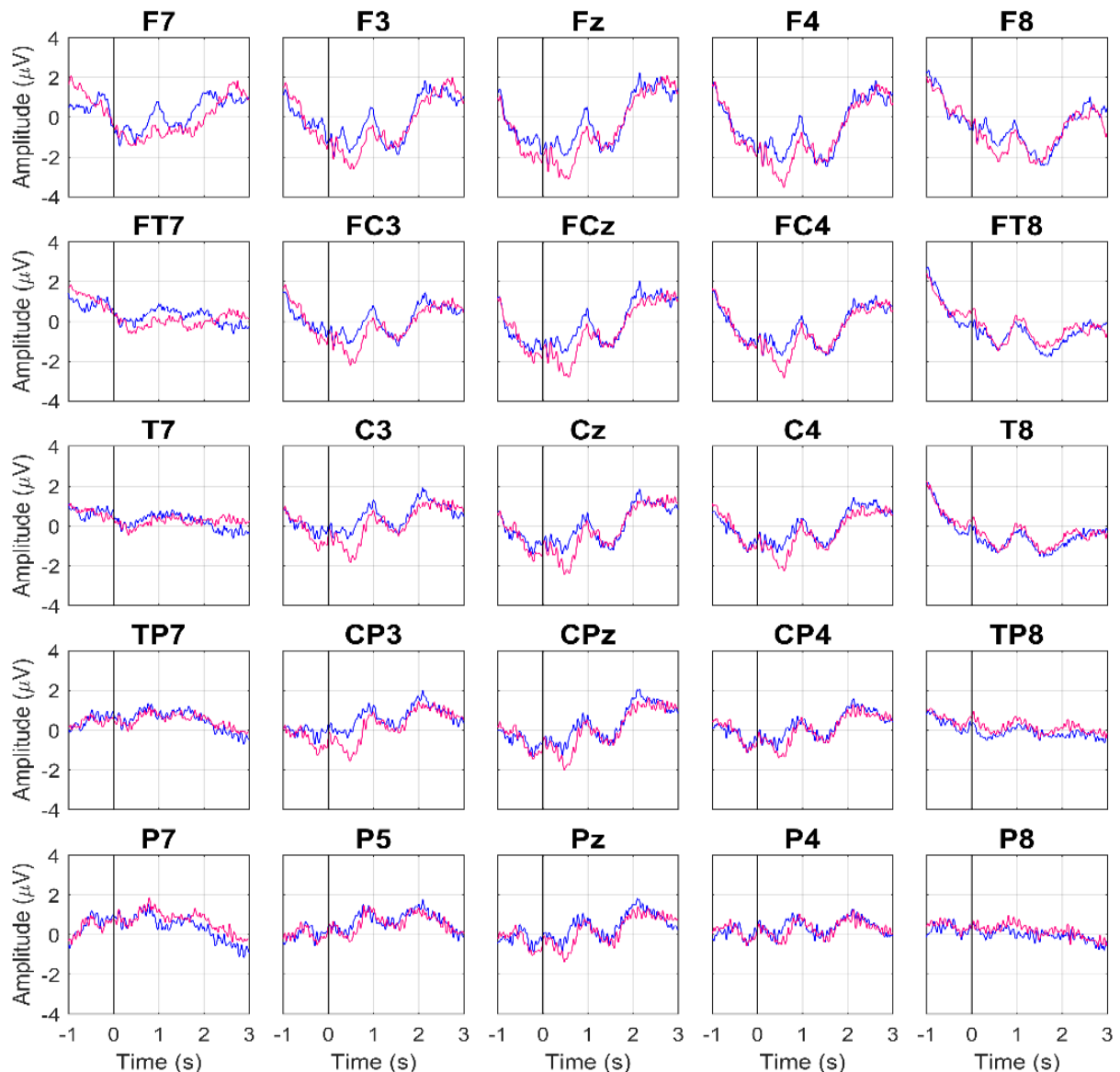
➤ Control group: Within group comparison when presented congruent & incongruent sentences → N400 present, t-test (p=0.02)

➤ Listening concern group: Within group comparison when presented congruent & incongruent sentences → N400 absent, t-test (p>0.05)
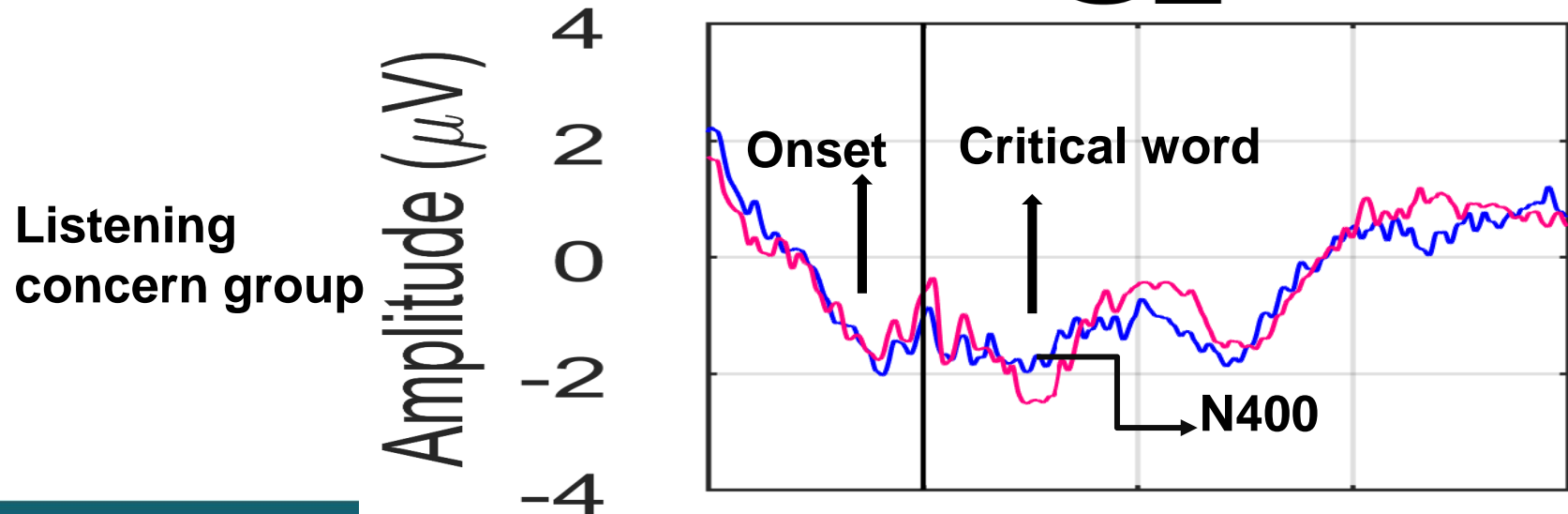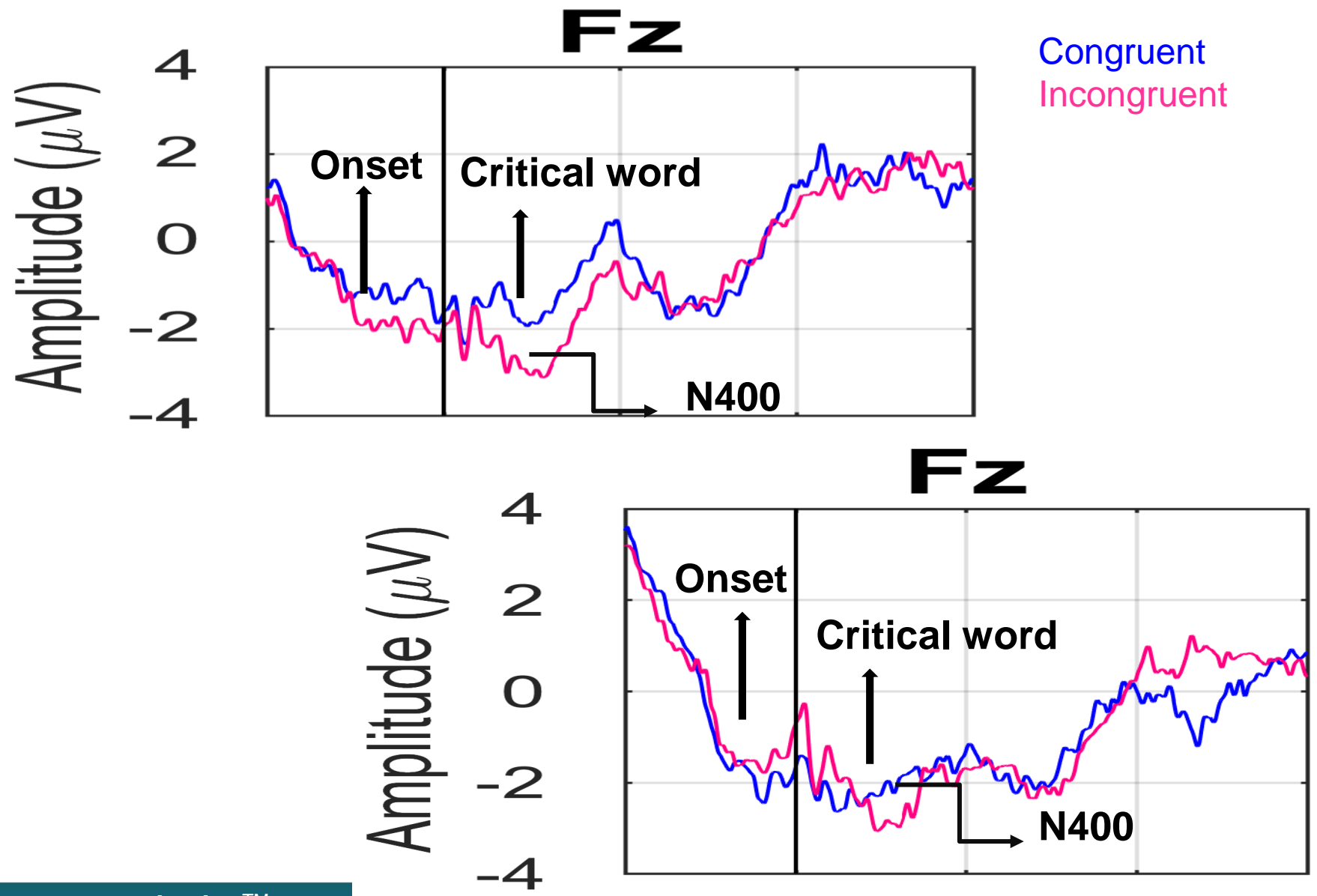
Results

Congruent
Incongruent

Control group

Listening concern group

Results

Cz

Congruent
Incongruent

Control group

Cz

Listening concern group

Results

➢ No significant differences on Multivariate analysis of variance between groups (p>0.05), age used as co-variate

Individual analysis: Standardization was carried out
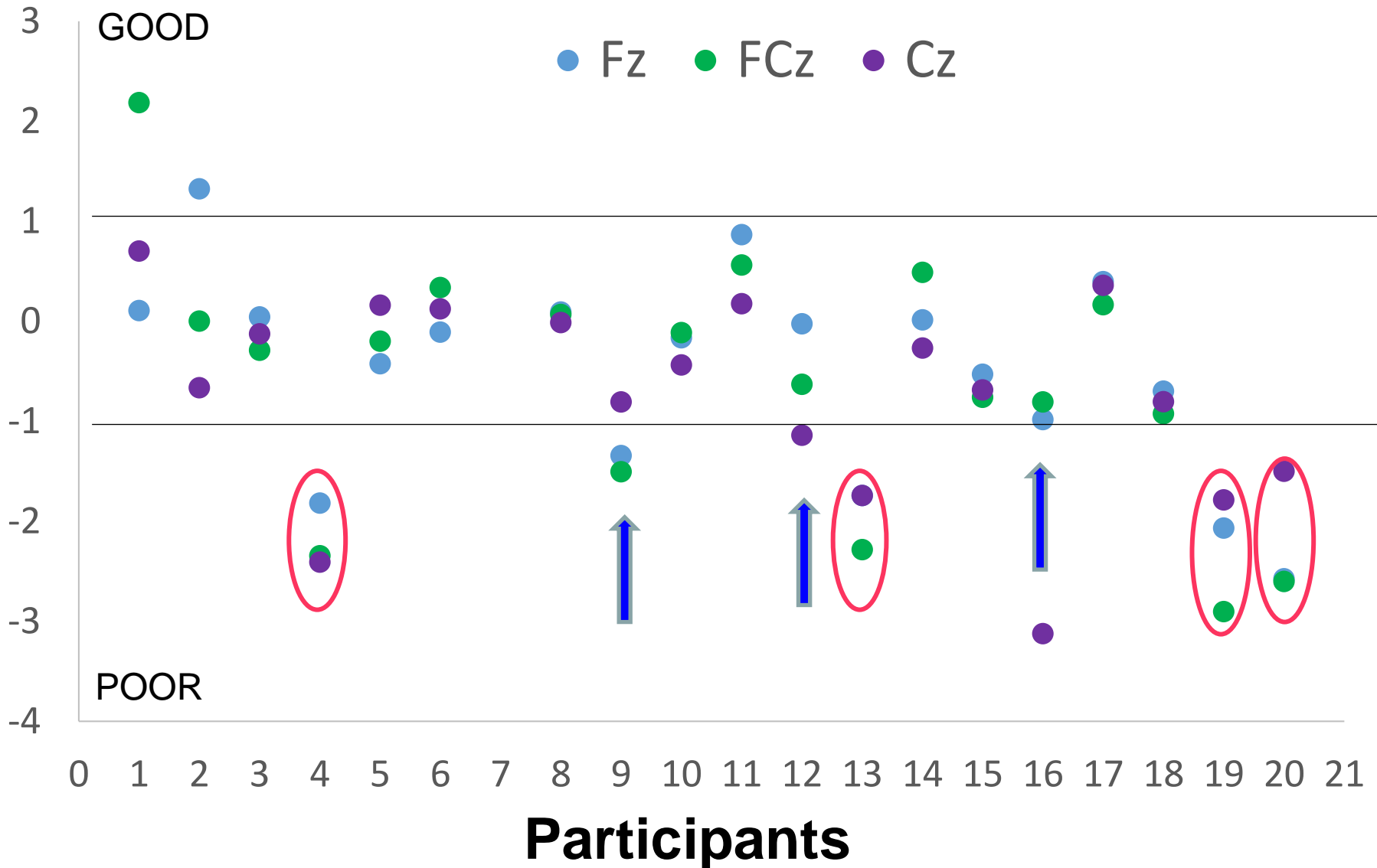
Calculating the Standard Score (Z-Score)

$$\text{Standard Score, } z = \frac{X - \mu}{\sigma}$$

TERMS:

μ = mean (pronounced 'mu')

X = score

σ = standard deviation (pronounced 'sigma')

Discussion

Why we didn't see an evident difference

1) Amount of noise exposure

2) Type of Noise exposure: recreational V/s occupational

(Le prell et al., 2016 & Yeend et al 2017)

2) Questionnaire information: over-estimate/ underestimate their difficulties

Future directions

1) Further analyses including clusters (groups of EEG channels) may clarify the potential of the N400 as an objective measure of speech understanding

2) Time frequency analysis to be carried out

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