



# Study on the Relationship between Postprandial Brain Function Decline and Blood Glucose Levels

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# Self-introduction

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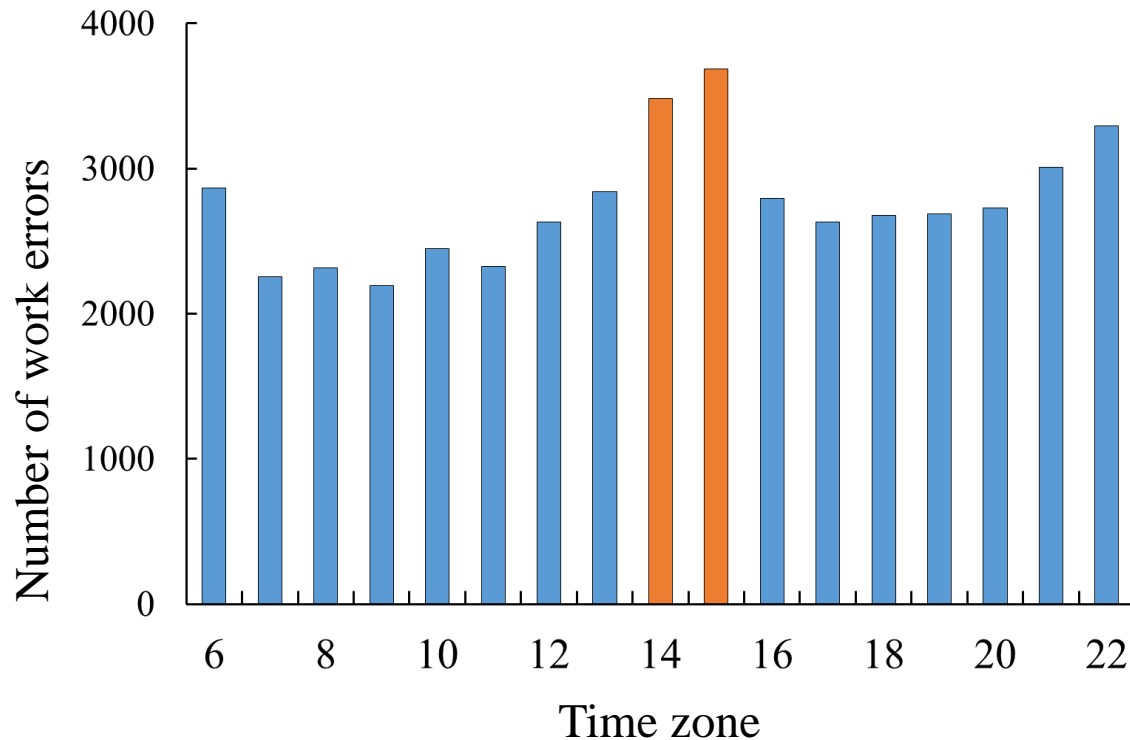
Brief Biographical History: 2021- Received B.S. degree from Toyama  
Prefectural University  
2021-Graduate School of Engineering,  
Toyama Prefectural University

Main Works: “Study of changes over time in breath alcohol concentration and  
brain function induced by low-impact drinking.” Journal of Advanced  
Computational Intelligence and Intelligent Informatics, Vol.27, No.3, 2023.



# Background

The strong sleepiness that occurs after lunch is called **post-lunch dip (PLD)**, and it **reduces brain function**, leading to decreased work efficiency and work errors\*.



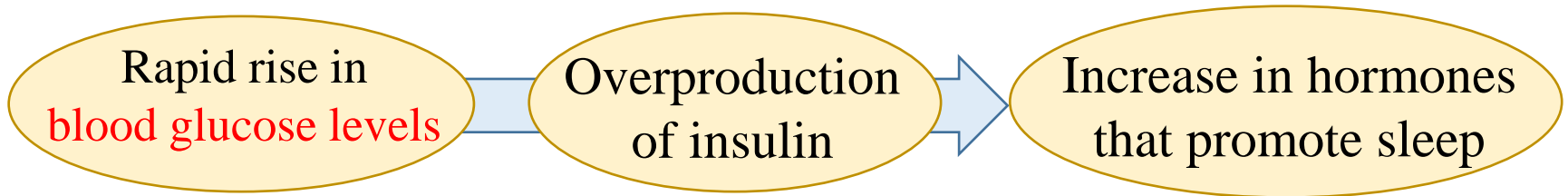
Number of work errors and time of day in Sweden\*.



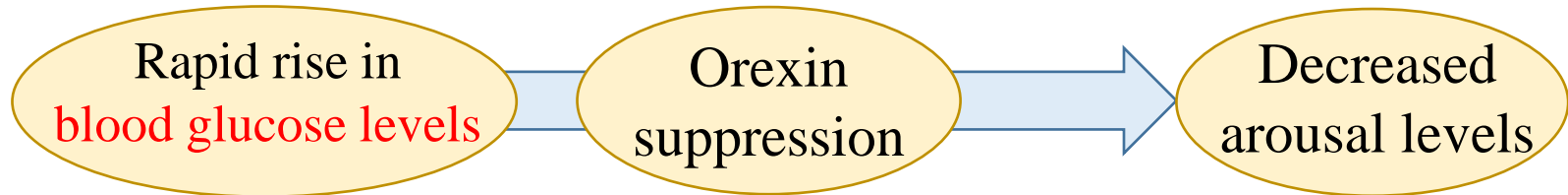
# Mechanism of postprandial drowsiness

## Hypothesized mechanism of postprandial drowsiness

- Rapid rise in blood glucose levels.



- Neuropeptide inhibition

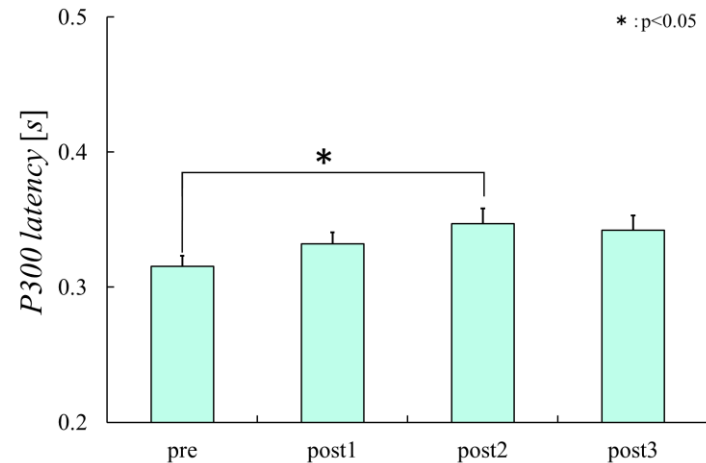
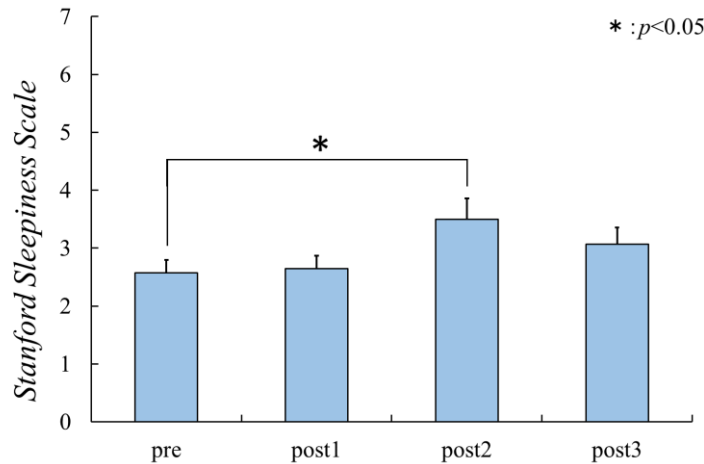


Various hypotheses have been proposed,  
but they have yet to be elucidated.



# Initiatives by this Laboratory

Development of a quantitative evaluation method for PLD using event-related potentials\*



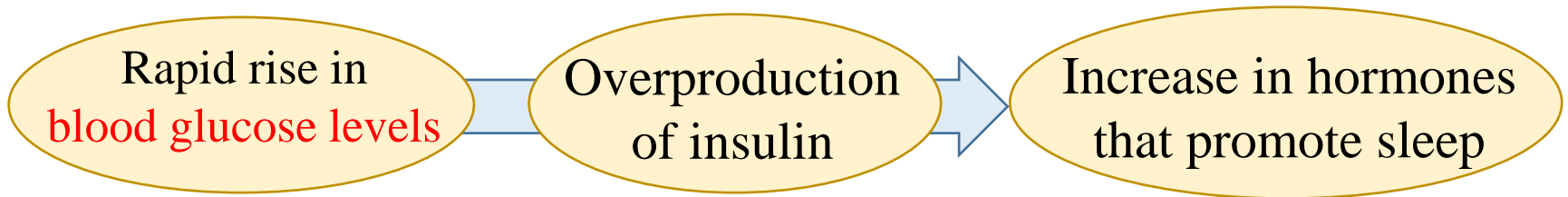
Significant changes in ERP with onset of subjective sleepiness

The ERP was validated as an objective indicator of transient brain dysfunction, fatigue, and sleep in PLD.

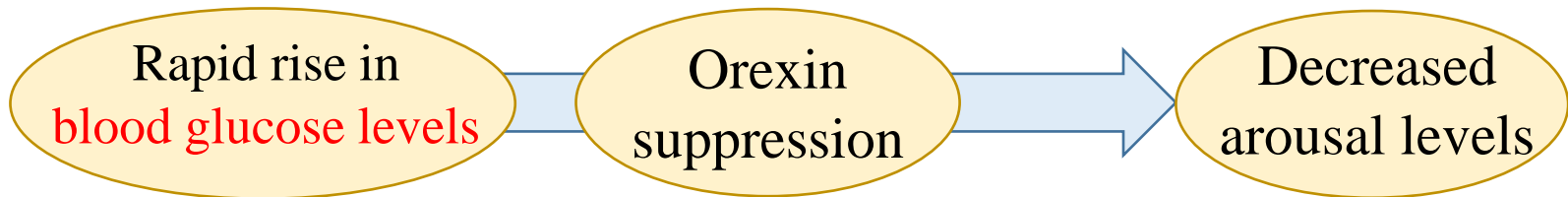
# Mechanism of postprandial drowsiness

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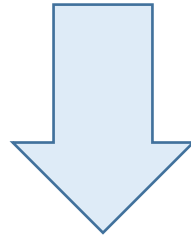


Need to study the relationship between **blood glucose levels** and postprandial decline in brain function.



# Mechanism of postprandial drowsiness

Need to study the relationship between **blood glucose levels** and postprandial decline in brain function.



Measure ERP and blood glucose levels before and after consumption of foods with different carbohydrate content



# Event-Related Potential: ERP

## Event-Related Potential: ERP

It is a type of EEG discovered by Walter et al.  
Brain potential fluctuation induced by some event

## Feature

- Reflects psychological events and is applied as an indicator of brain function
- ERPs elicited by different types of stimuli and presentation methods

## ERP Types

P300, Contingent Negative Variation, N400, Mismatch Negative Potential



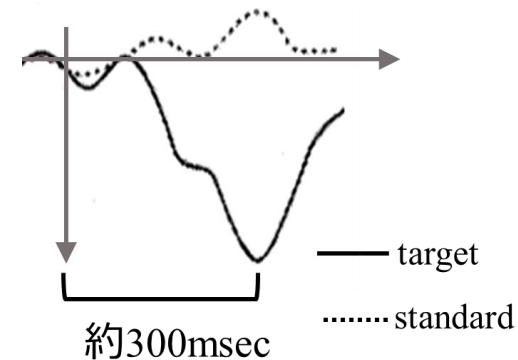


# P300

Positive brain potential changes that appear **about 300 ms** after stimulus presentation when attention is focused on the stimulus

## P300 latency

- Time until P300 vertex appears
- Reflects time spent in cognitive processing



Typical waveform of P300 waveform

It is used as an evaluation index for fatigue and AD/HD



# Contingent Negative Variation: CNV

Event-related potentials that emerge when two types of stimuli are presented to a subject at regular intervals and a motor response is required to the second stimulus

## ➤ Main components of CNV

Early CNV :

0.4-0.8 s after presentation of the first stimulus

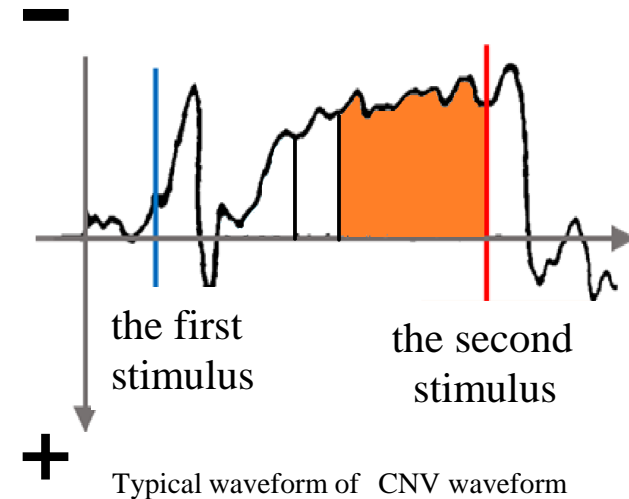
Reflects the level of awakening

Late CNV :

1.0 s before second stimulus presentation

- up to presentation

Reflects sustained attention function



# Experimental Methods

## High-sugar food ingestion group (HI group)

Participants : 20 young people ( $21.71 \pm 0.82$  age)

Dietary load : White bread (two x 20 mm thick slices)

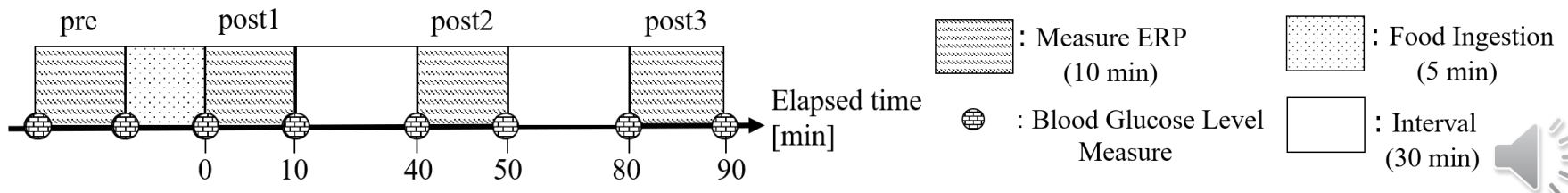
Water (285 ml)

## Low-sugar food ingestion group (LI group)

Participants : 10 young people ( $21.80 \pm 1.16$  age)

Dietary load : low-sugar bread (approximately 120 g)

Water (285 ml)



# Measuring Device

Measuring device : g.USBamp  
(g.tec medical engineering)

Sampling frequency : 512 Hz

Band pass filter : 0.01 – 30 Hz

Notch filter : 60 Hz



## Electrode attachment position

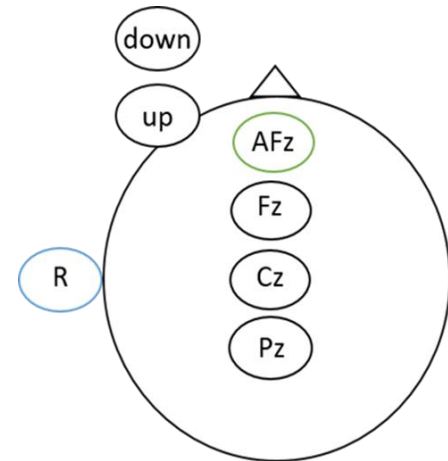
Extended 10-20 Act Fz, Cz, Pz

Ground electrode : AFz

Reference electrode: Left earlobe

Electro-oculogram measurement:

two locations above and below the left eye



# Blood glucose level measurement

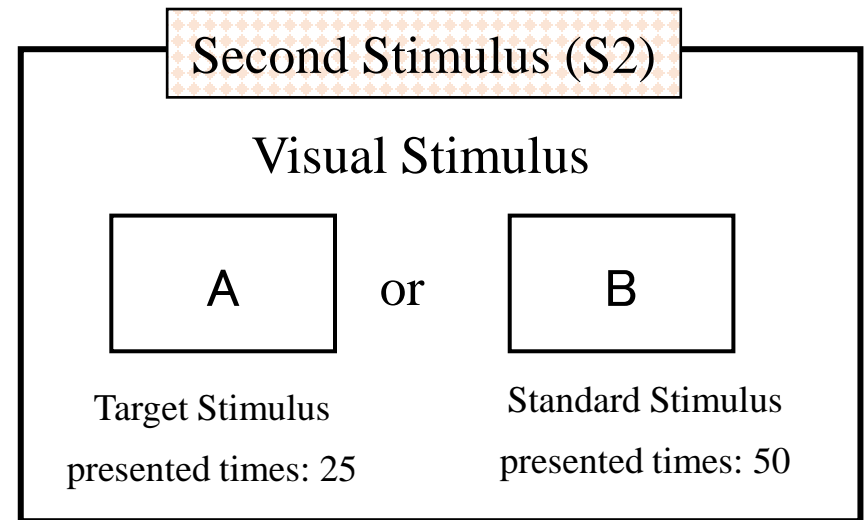
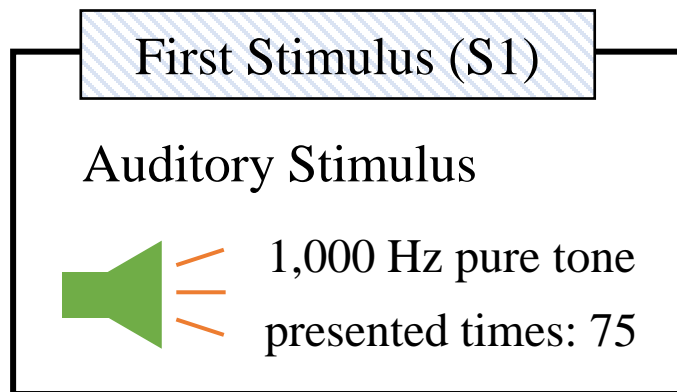
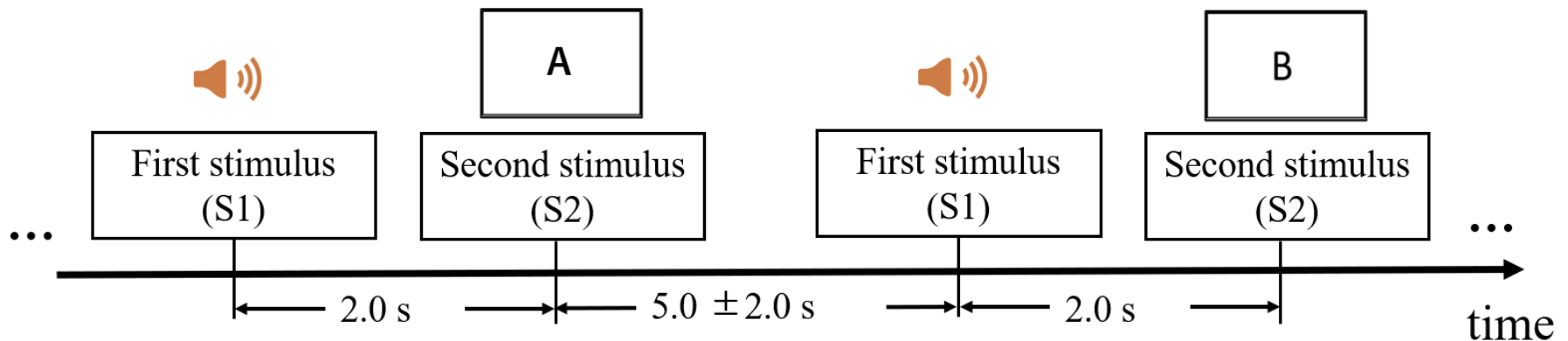
FreeStyle Libre (Abbott Japan LLC )



- ✓ Record glucose concentrations in interstitial fluid that correlate well with blood glucose levels
- ✓ The average value is the representative value at each time.



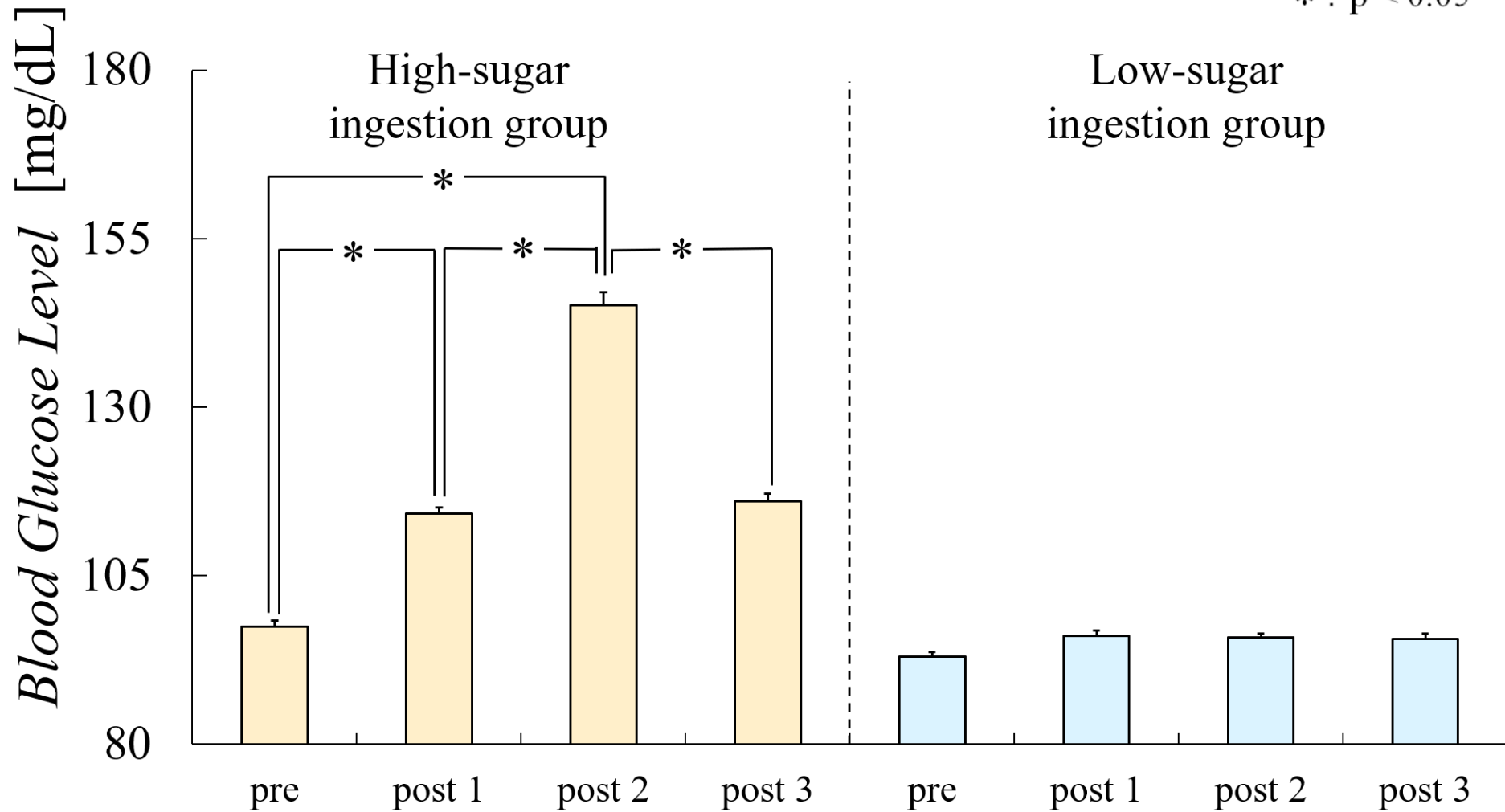
# ERP Measurement Tasks



The "A" and "B" images of the second stimulus were presented at random, and only when the "A" image was presented, a quick press of the button was requested

# Result: Blood glucose level (Mean $\pm$ SE)

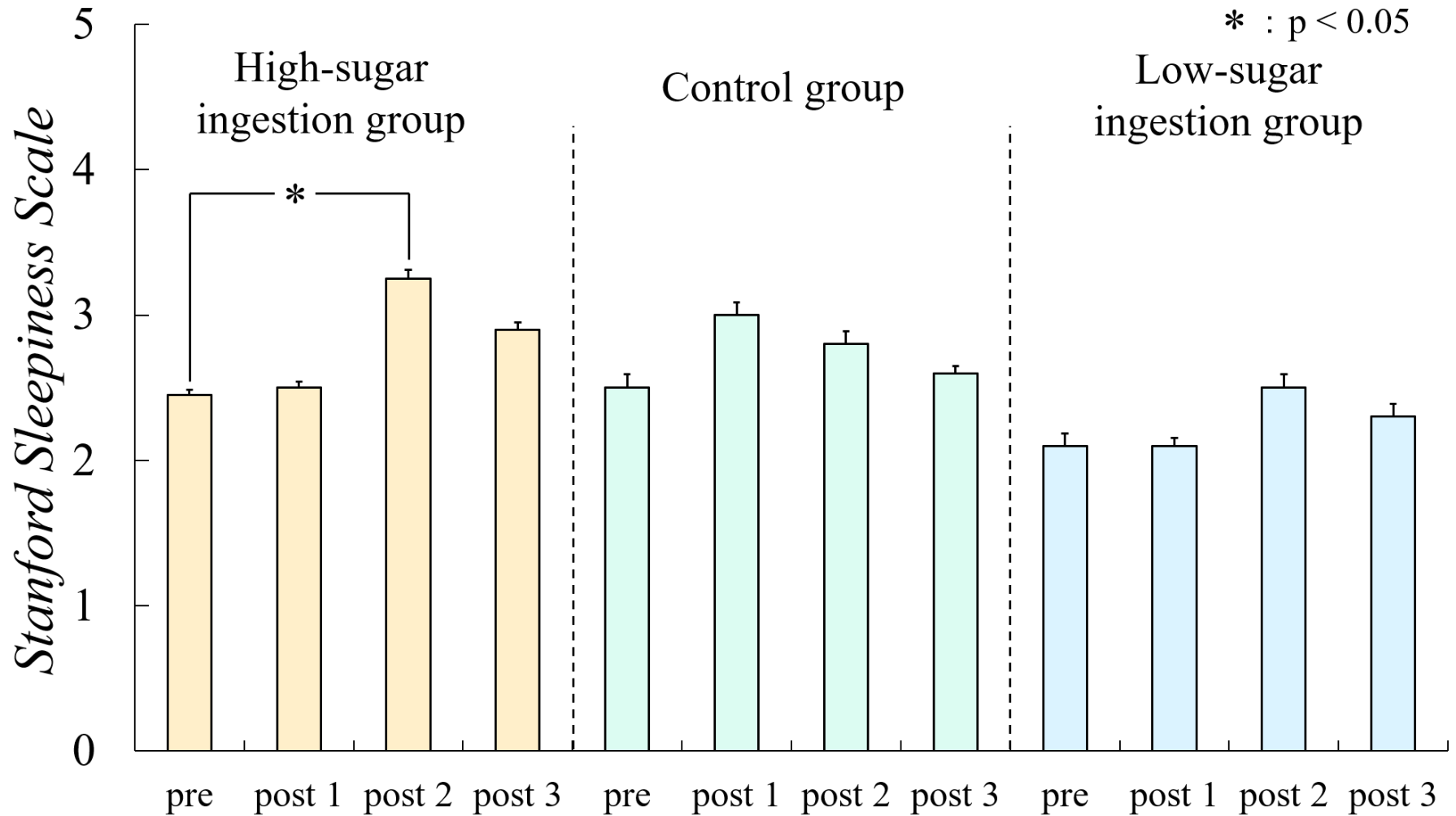
\* :  $p < 0.05$



Significant variation in values only  
in **High-sugar food ingestion group** (  $p < 0.05$  )



# Result: Stanford Sleepiness Scale (Mean $\pm$ SE)

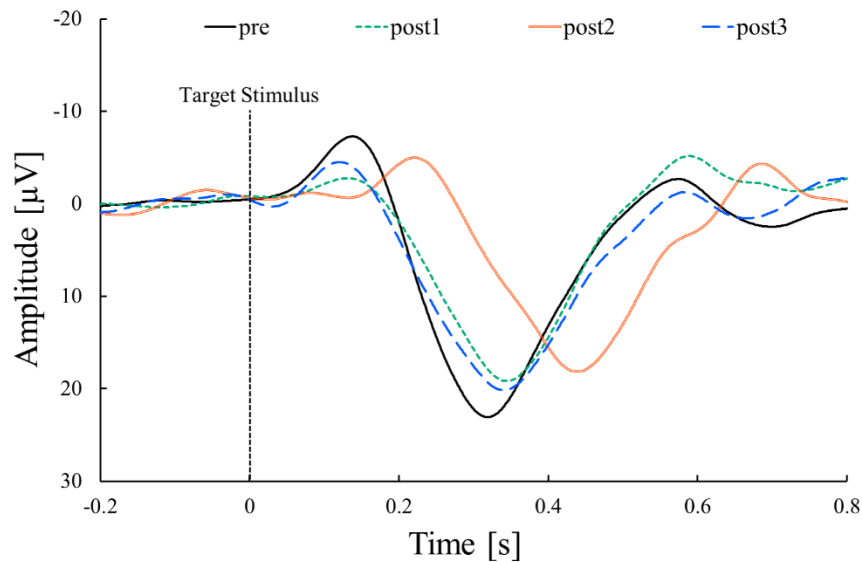


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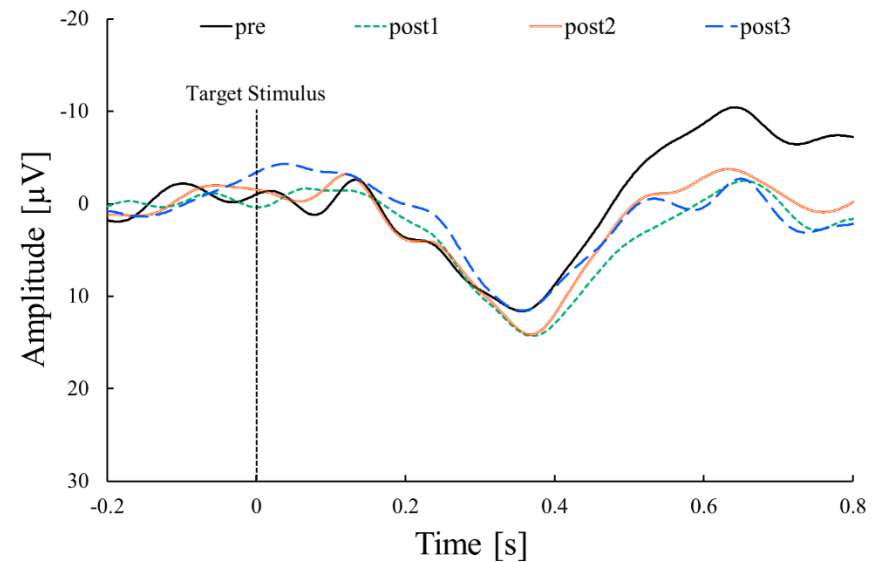




# Typical waveform of P300



High-sugar food ingestion group

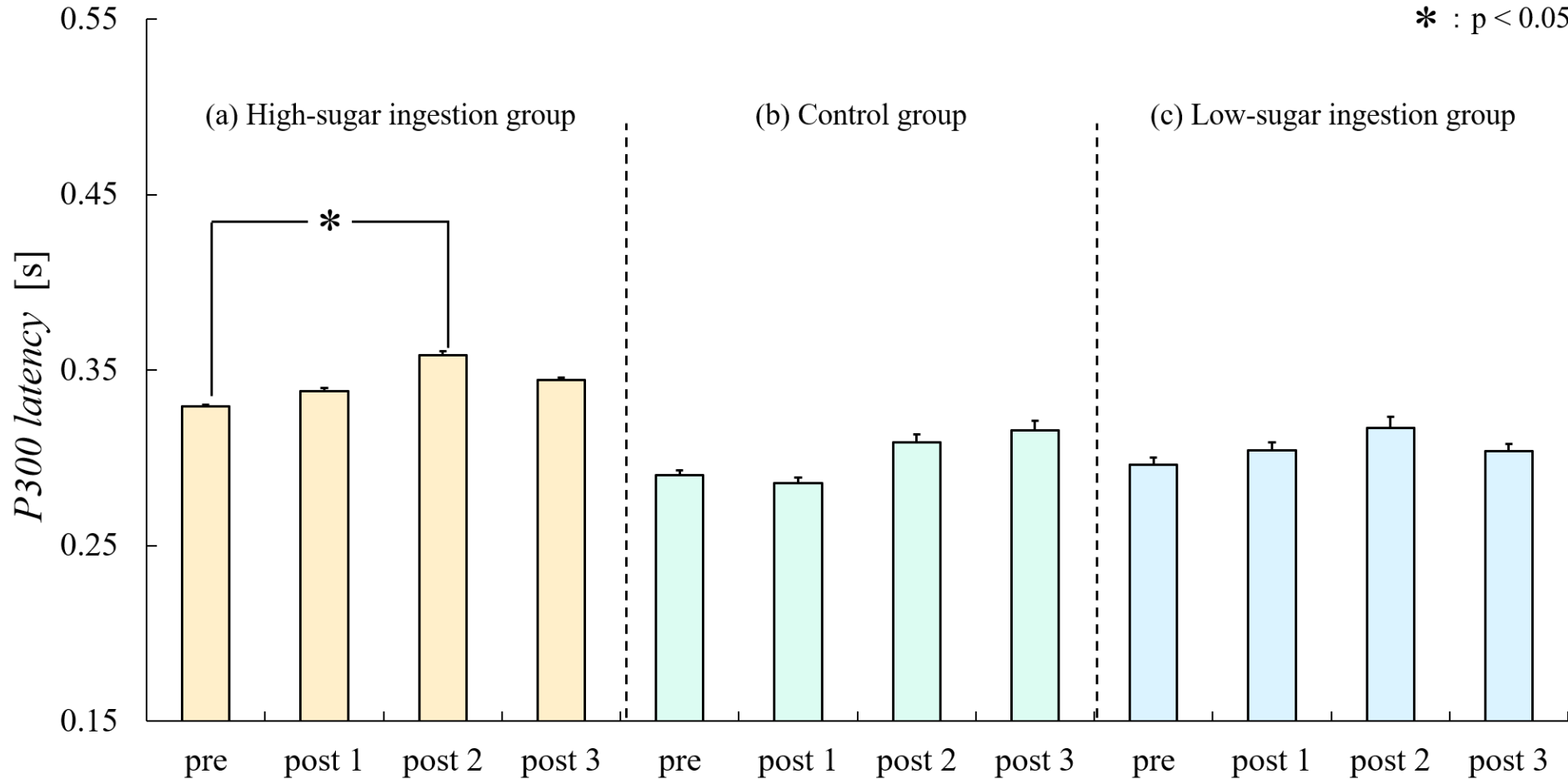


Low-sugar food ingestion group



# Result: P300 latency (Mean $\pm$ SE)

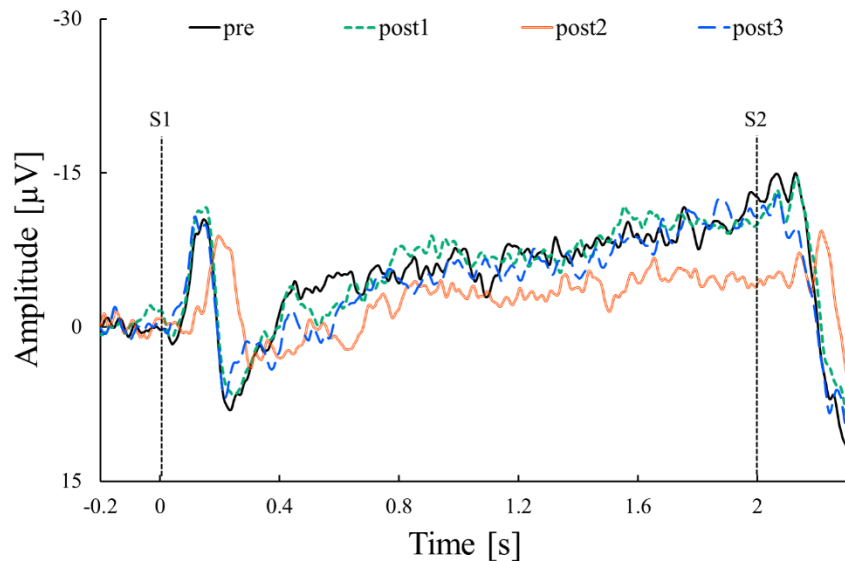
\* :  $p < 0.05$



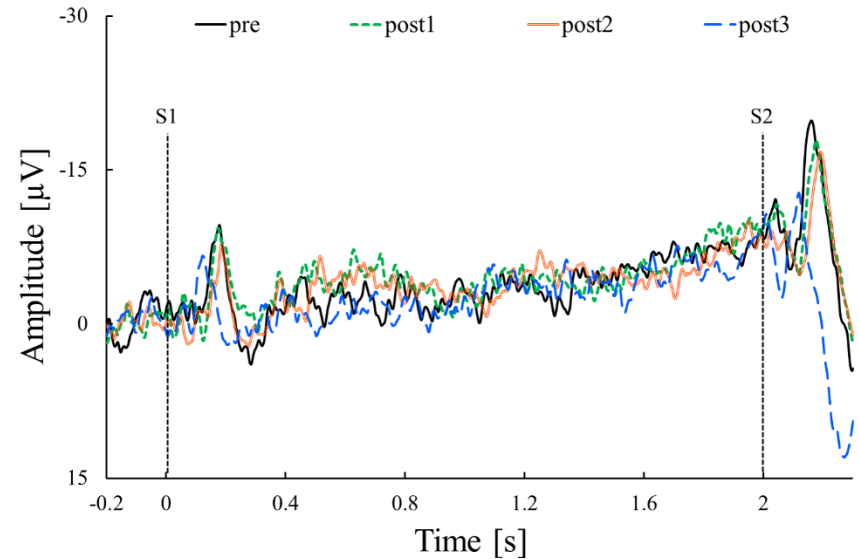
Significant variation in values only  
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# Typical waveform of CNV



High-sugar food ingestion group

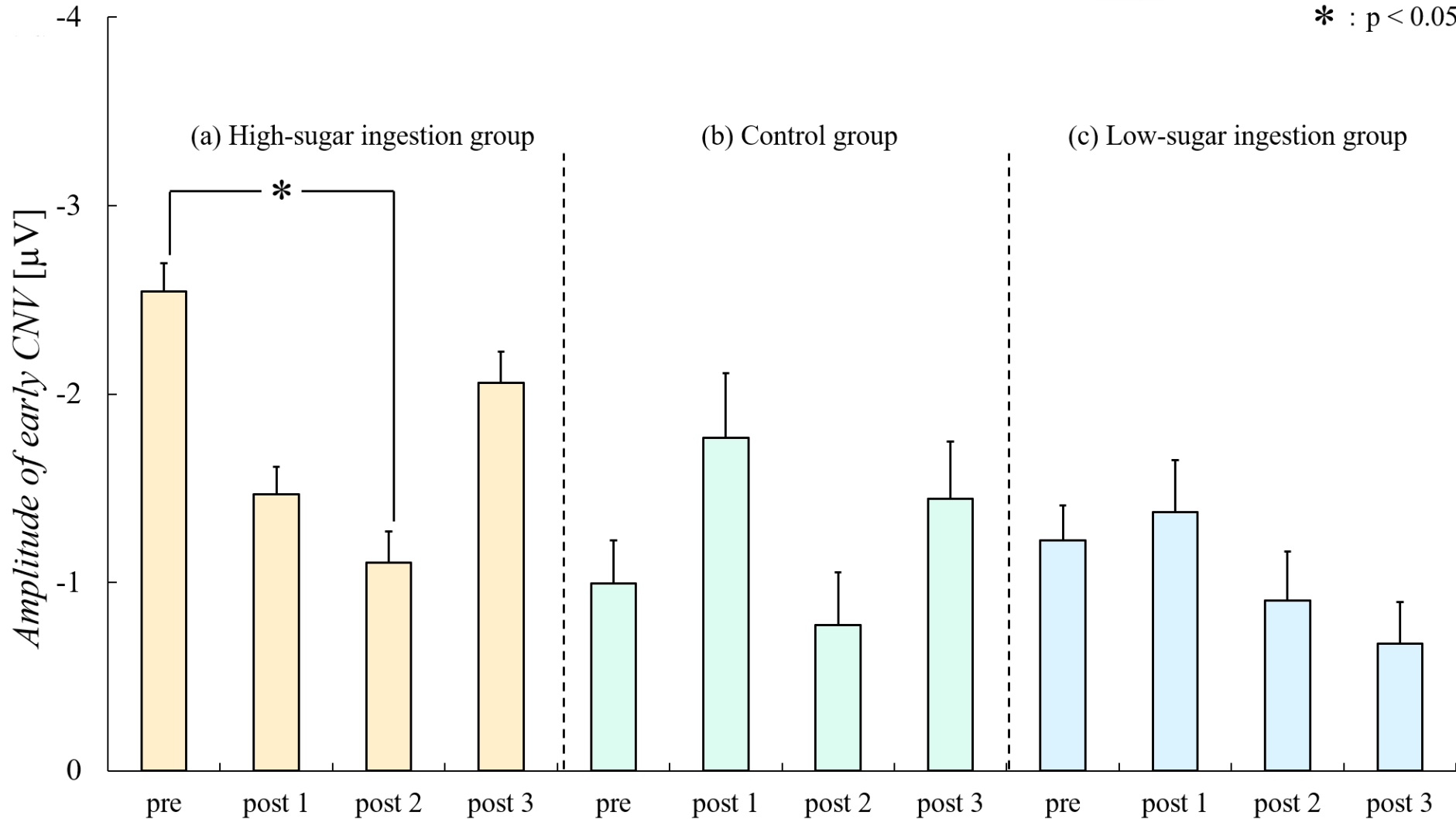


Low-sugar food ingestion group



# Result: Early CNV (Mean $\pm$ SE)

\* :  $p < 0.05$

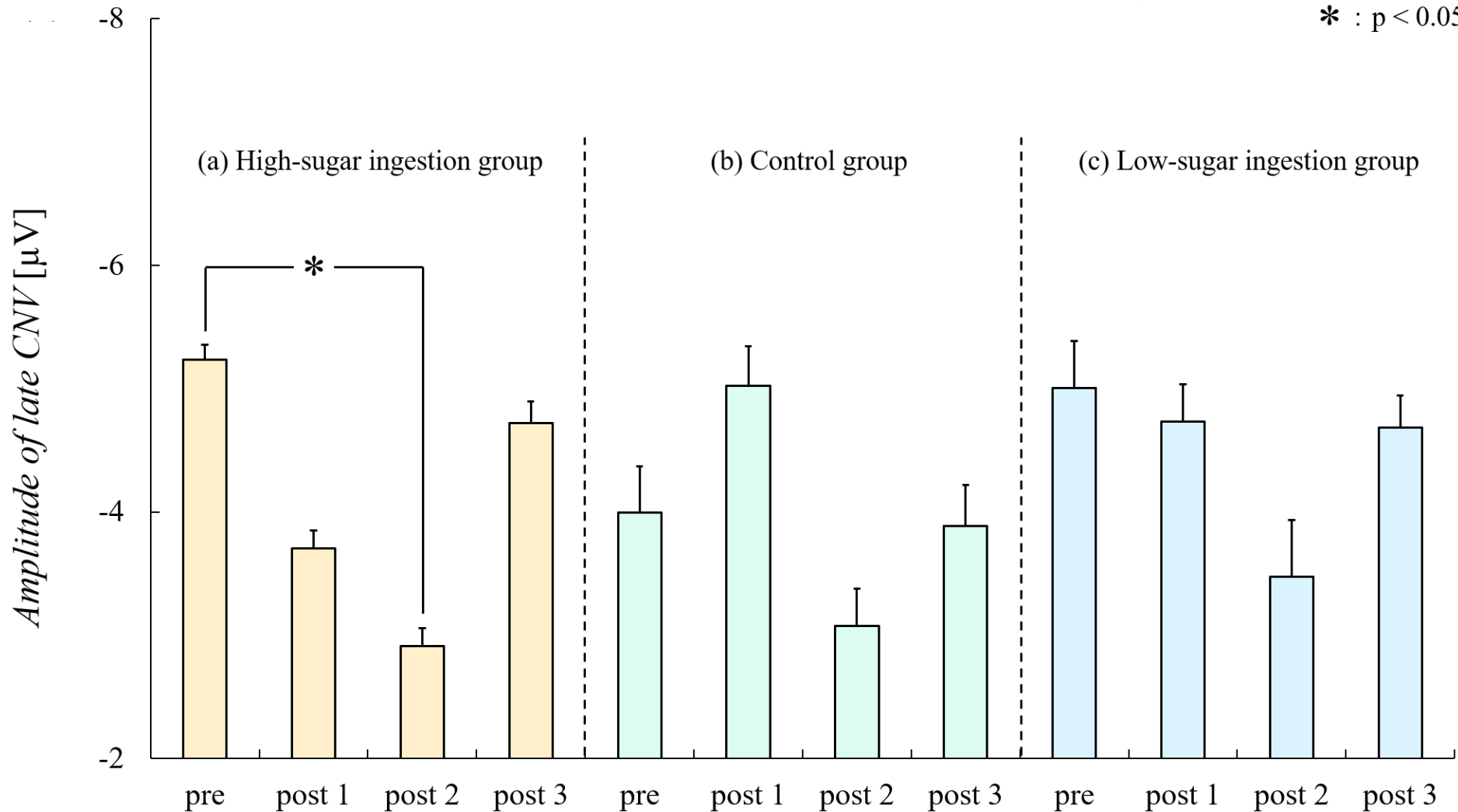


Significant variation in values only  
in **High-sugar food ingestion group** (  $p < 0.05$  )



# Result: Late CNV (Mean $\pm$ SE)

\* :  $p < 0.05$



Significant variation in values only  
in **High-sugar food ingestion group** (  $p < 0.05$  )



# Discussion

- Significant changes in blood glucose, SSS, and ERP in the High-sugar food ingestion group 40 min after eating

Fluctuations in postprandial blood glucose levels affect the development of PLD

- In the High-sugar food ingestion group, brain function decreased only after 40 minutes of eating, when blood glucose levels were maximal

The degree of blood glucose elevation influences the development of PLD.



# Discussion

- The explanation by "neuropeptide inhibition," a research hypothesis regarding the mechanism of PLD generation, is that orexin, which controls the level of arousal in the brain, is suppressed in response to the degree of blood glucose level increase.

Results support the "neuropeptide inhibition" explanation.



# Conclusion

## 【Purpose】

- Investigation of the relationship between transient brain function decline after eating and blood glucose level fluctuations.

## 【Result】

- Brain function decreased only in the group with significant changes in blood glucose levels

## 【Future】

- Detailed study of the relationship between blood glucose and PLD due to loading of medium GI foods and multiple foods

