

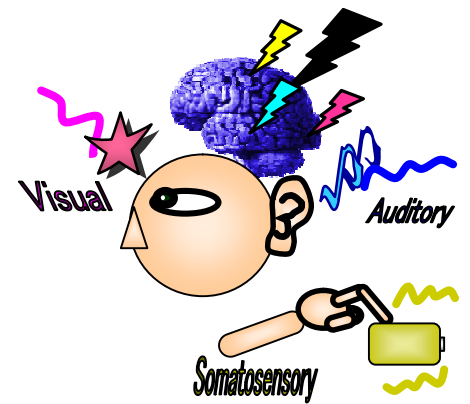
# Top-down influences on the crossmodal gamma band oscillation

Noriaki Kanayama<sup>1</sup>, Luigi Tame<sup>2</sup>, Hideki Ohira<sup>1</sup>,  
Francesco Pavani<sup>2</sup>

<sup>1</sup> Nagoya University

<sup>2</sup>Trento University (CiMec)

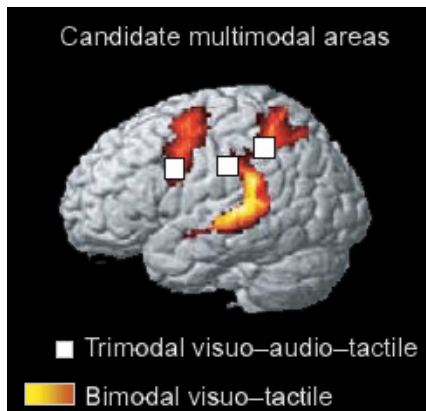
# Multimodal Integration



- Multimodal Integration Process
  - The process to perceive some input from different modalities as integrated information.
- Visuotactile Congruency Effect
  - has been considered as an index of the multimodal process in the brain cortex.
  - could be affected by the conscious state or knowledge of the arm position
  - the distance between the visual and tactile stimulus (Spence et al., 2004).
  - the existence of the rubber hand which mimicked the participants hand (Pavani et al., 2000).
  - the mirror image of arm (Farne et al., 2002).
  - the distance made by the transparent barrier (Kitagawa et al., 2005)

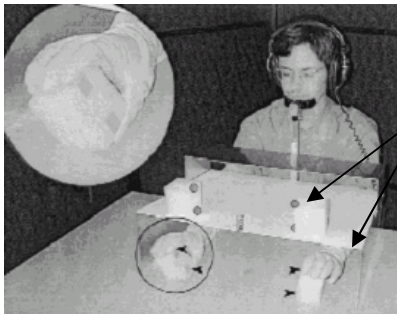
- Neural Correlates

- Bimodal neuron
- respond to both of visual and tactile stimulus on the peripersonal space.
- located at the parietal cortex (parietotemporal junction or occipitoparietal junction, etc).
- could be observed by the macaque monkey.
- The similar area of human could respond the multimodal stimulus



Calvert et al., 2005

# Congruency Effect and Rubber hand illusion



With distance between visuotactile stimuli, the congruency effect diminished



Rubber hand could compensate the distance between visuotactile stimuli and enlarged congruency effect

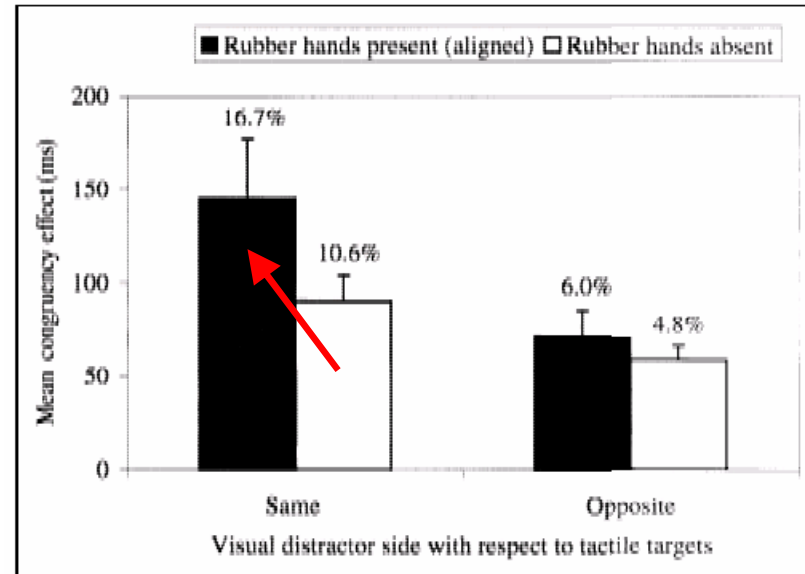


However, when the rubber hand was rotated 90 degree and not valid as the participant's arm position, congruency effect was not enlarged by the rubber hand

**Table 1.** Mean reaction time and percentage of errors

Target-distractor congruence (upper vs. lower position)	Position of distractor	Reaction time (ms) <sup>a</sup>	Error (%)
Rubber hands absent			
Congruent	Same side	462 (16)	1.6
	Opposite side	477 (19)	2.5
Incongruent	Same side	552 (25)	12.2
	Opposite side	536 (24)	7.3
Rubber hands present (aligned)			
Congruent	Same side	488 (20)	1.2
	Opposite side	503 (26)	1.8
Incongruent	Same side	633 (47)	17.9
	Opposite side	574 (35)	7.8

<sup>a</sup>Standard errors are given in parentheses.



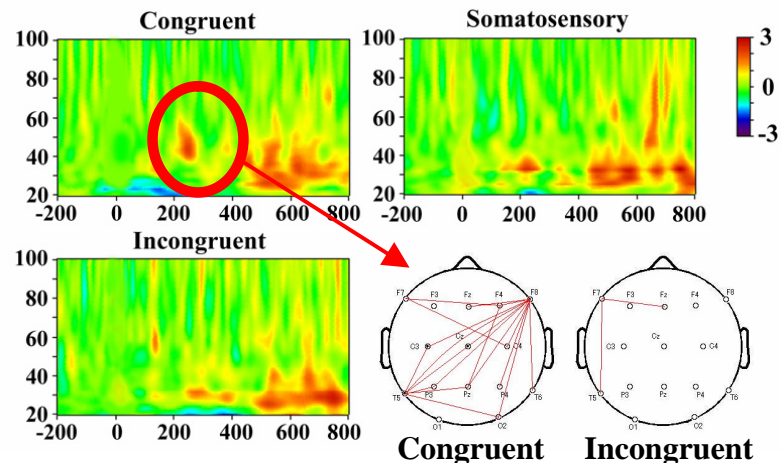
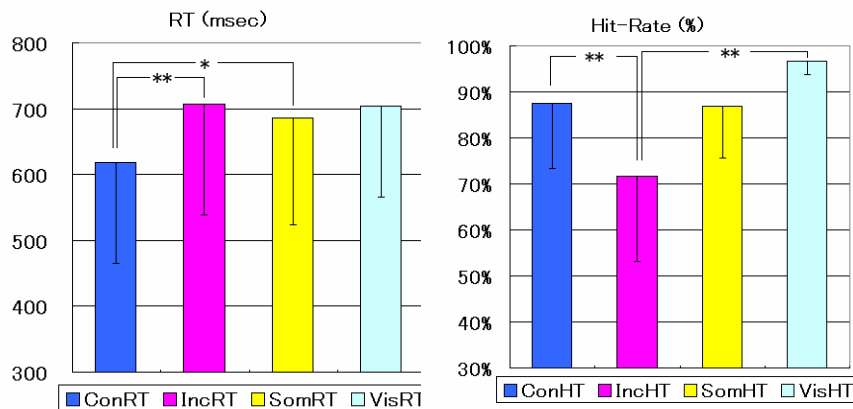
# A question on the visuotactile process

- Top down and bottom up process on the multimodal integration or crossmodal interaction process.
  - Neuroscience studies suggested the role of the area respond to lower sensory level process.
  - Bimodal neuron at the parietal region use the visuotactile stimulation map of the peripersonal space.

Lower sensory level process evoked the multisensory integration and crossmodal interaction effect.
  - Psychological studies suggested the top down process could affect the multimodal integration and crossmodal interaction process
  - Some conscious state modulate the behavioral index of the processes

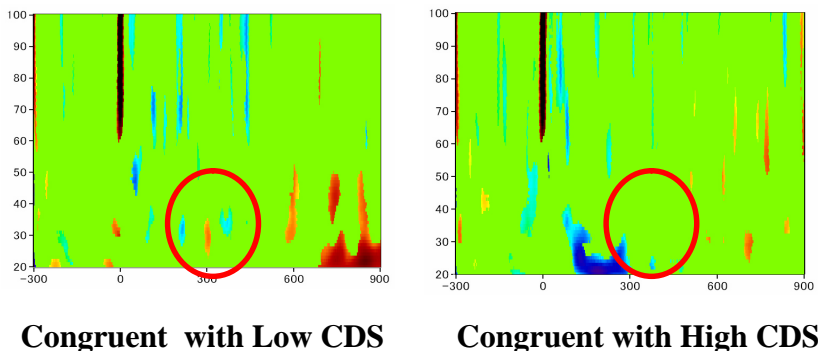
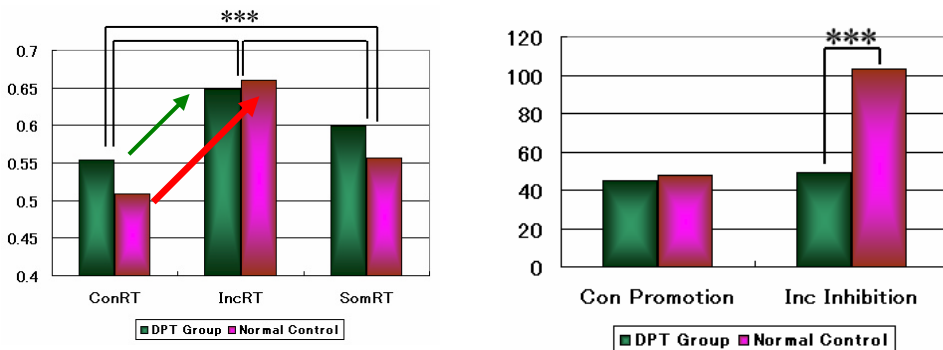
Higher cognitive level process modulate the multisensory integration and crossmodal interaction effect.

# Suggestion from our previous studies



Visuotactile integration process could be reflected by the gamma band activity at the parietal area and its whole-brain synchronization.

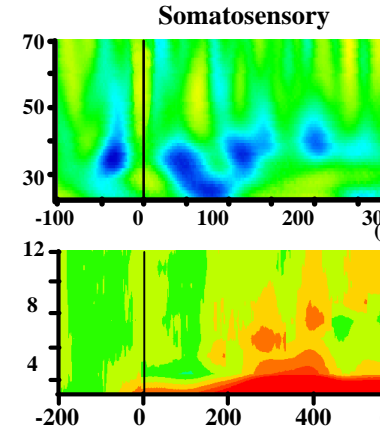
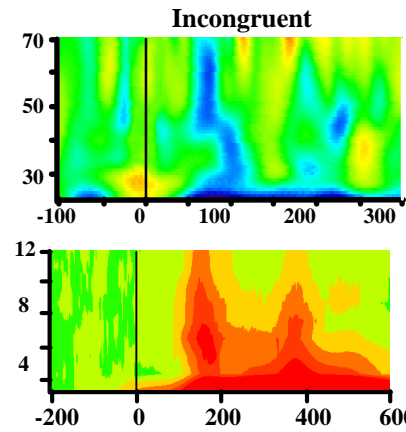
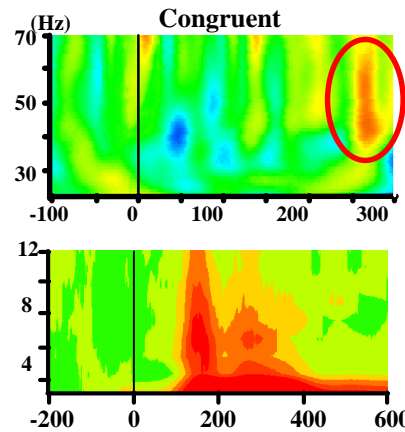
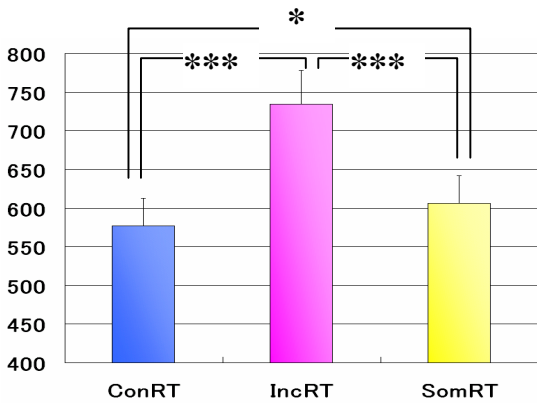
Kanayama et al., 2007, Psychophysiology



Individuals with Depersonalized characteristic shows reduction of Congruency Effect and gamma band activity.

Kanayama et al., 2008, Brain and Cognition

# Suggestion from our previous studies



Visuotactile integration process could be reflected by the gamma band activity, and the interference process could be reflected the theta band oscillation during 300-500ms. (without rubber hand illusion)

Kanayama et al., submitted

Research question:

What is the role of these components of two frequency-bands on multimodal process. For direct comparison between top-down and bottom up process.

Operational definition

Top down modulation on the multimodal process could be indexed by proportion of congruent trials.

Frequently-presented congruent condition could make an expectation for visuo-tactile congruent stimulation (and vice versa).

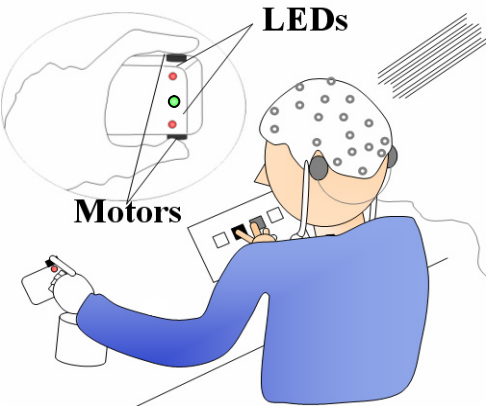
# Experimental design

- Participants
  - 12 Italian graduate students (5 female, age 25-33)
  - All right-handed, normal or corrected vision, and no history of psychiatric disease.
- Independent variables
  - Proportion of each condition (80% congruent/ 80% incongruent, across blocks)
  - Condition (Congruent, Incongruent)
  - Somatosensory block and condition (for baseline).
- Dependent variables
  - Behavioral data (RT, Hit-Rate, Congruency Effect)
  - Divided Congruency Effects
    - Congruency Promotion Effect/ Incongruency Inhibition Effect
  - EEG
    - Gamma band oscillation (250-350ms, 40-60Hz) at congruent condition
    - Theta band oscillation (100-300ms, 4-7Hz) at bimodal condition

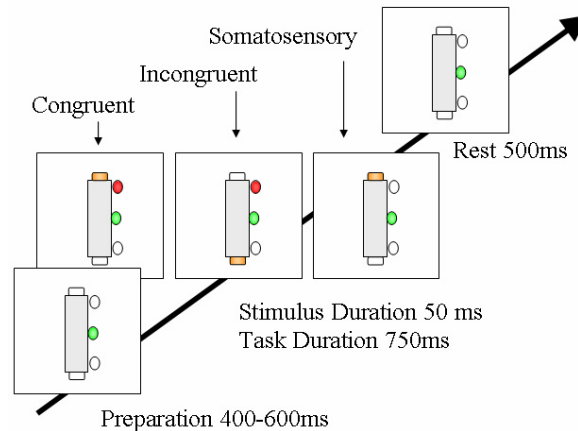
# Experimental Settings and flow

1. Wait the stimulus gazing the fixation point, grabbing the cube with LED and vibration motor.
2. The visuotactile input simultaneously occurs.
3. Detection the elevation of the tactile stimulus, ignoring the simultaneous visual distracter.
4. Respond the elevation of the tactile stimulus by pressing the corresponding bottoms.
5. Wait the next stimulus gazing the fixation point

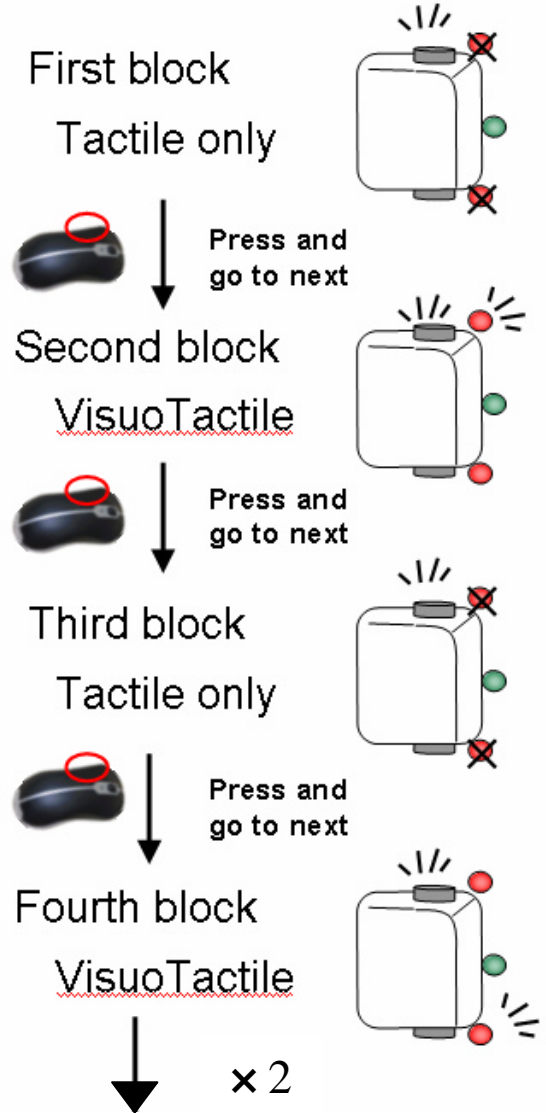
## Experimental Settings



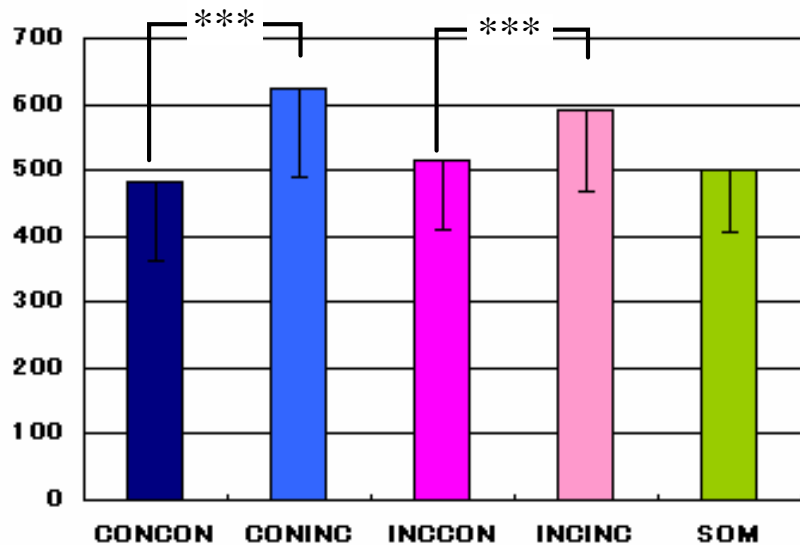
## The flow of 1 trial



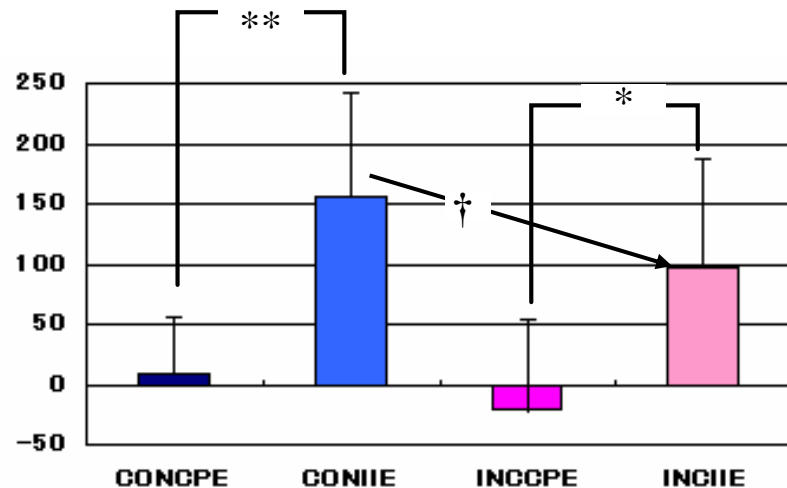
## The flow of Experiment



# Behavior –Response Times-

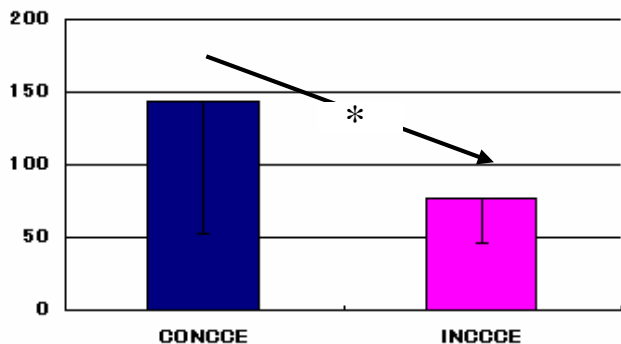


Congruency effect is significantly observed in both proportion



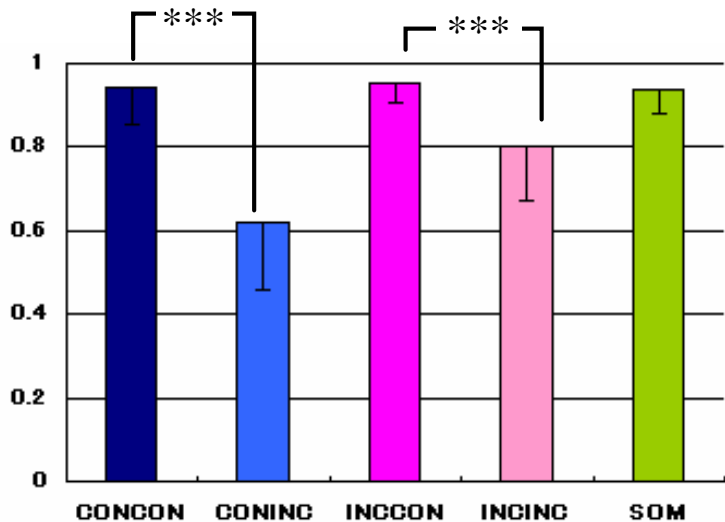
Incongruency Inhibition Effect is dominant in both blocks

Only Incongruency Inhibition effect is smaller in Incongruent 80% block than in Congruent 80% block

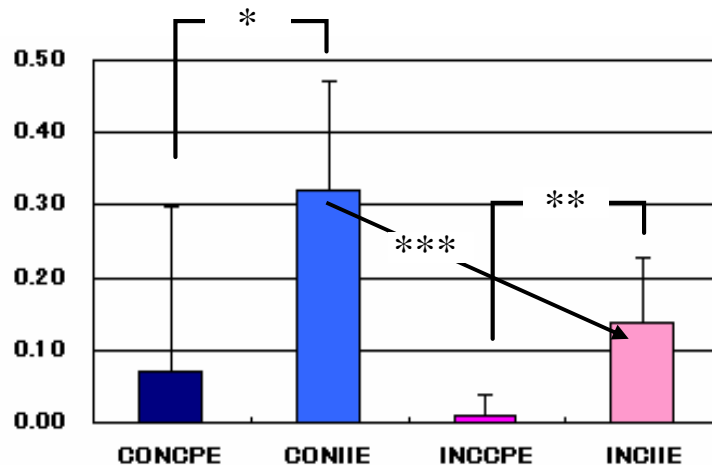


Congruency effect is smaller in Incongruent 80% block than in Congruent 80% block

# Behavior –Hit-Rates-

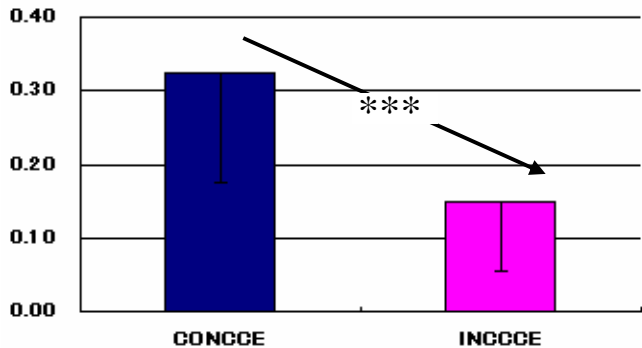


Congruency effect is significantly observed in both proportion



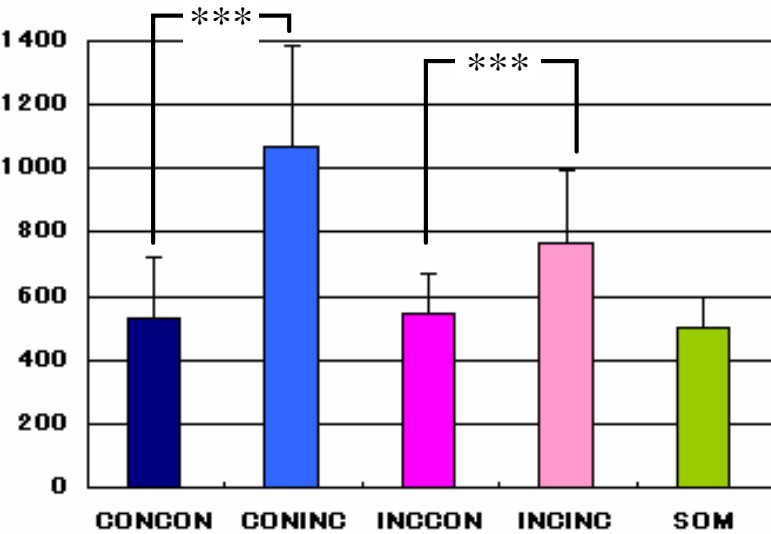
Incongruency Inhibition Effect is dominant in both blocks

Only Incongruency Inhibition effect is smaller in Incongruent 80% block than in Congruent 80% block

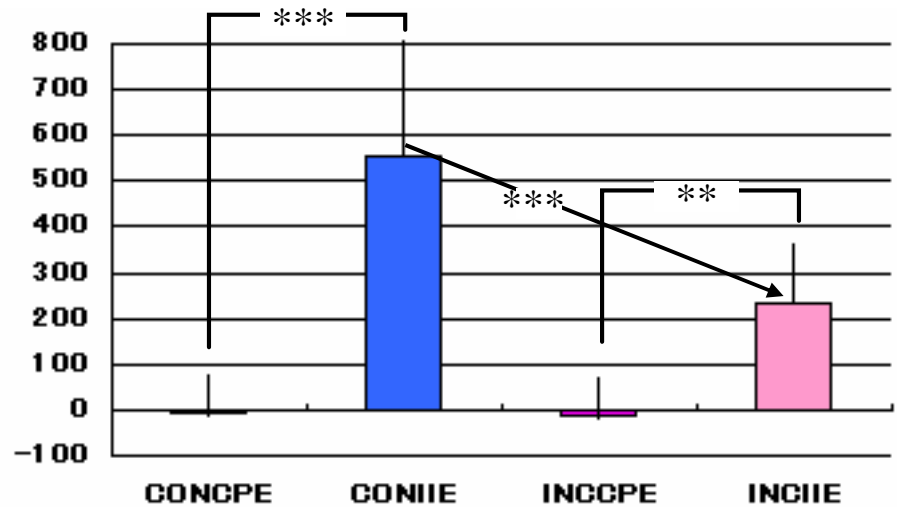


Congruency effect is smaller in Incongruent 80% block than in Congruent 80% block

# Behavior –Inverse Efficiency-

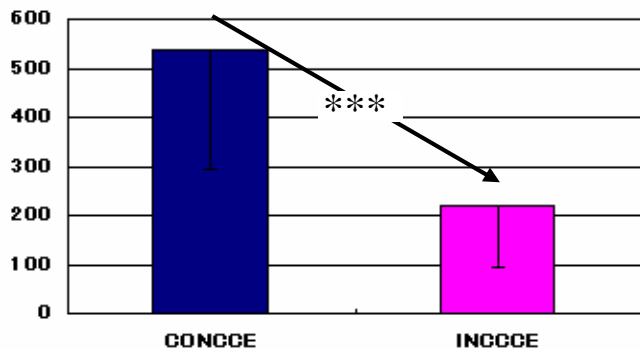


Congruency effect is significantly observed in both proportion



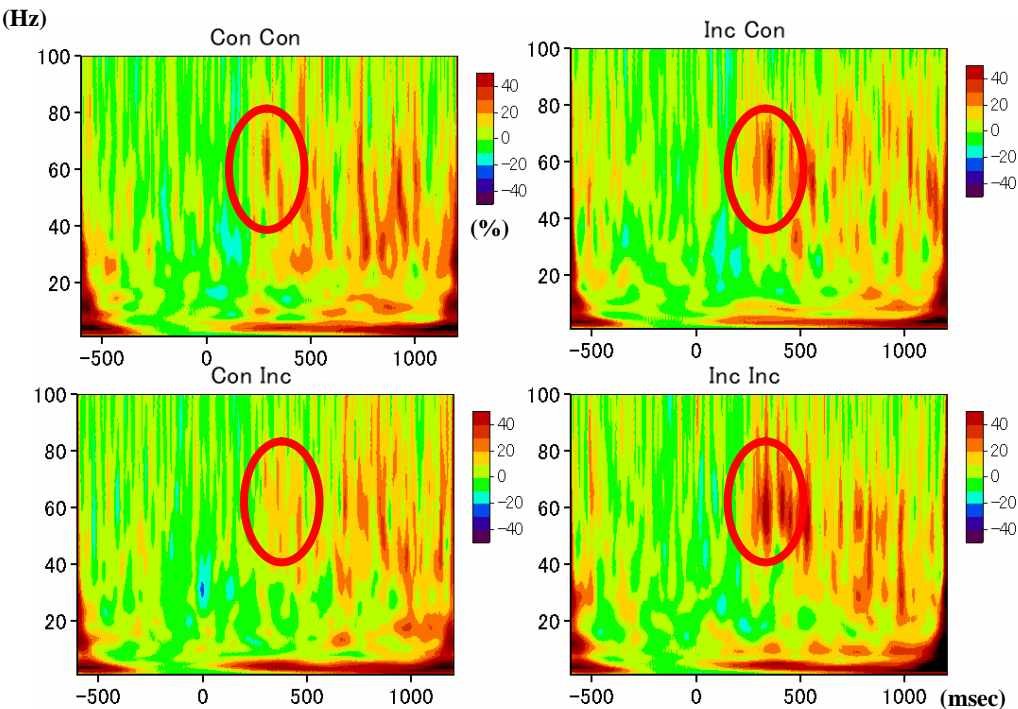
Incongruency Inhibition Effect is dominant in both blocks

The IIE difference between proportions is marginally significant



Congruency effect is smaller in Incongruent 80% block than in Congruent 80% block

# EEG Results

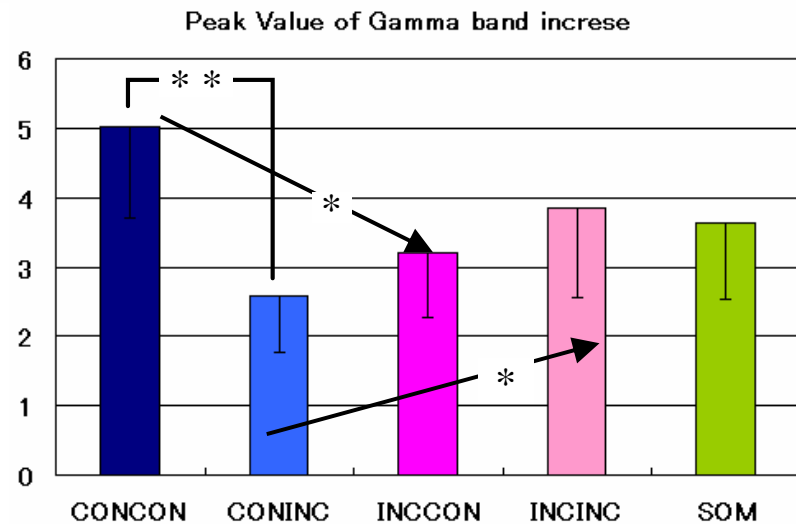


The significant main effect of condition ( $F(1,11)=6.36, p < .05$ ), which indicated the larger GBR for congruent condition ( $p < .05$ ).

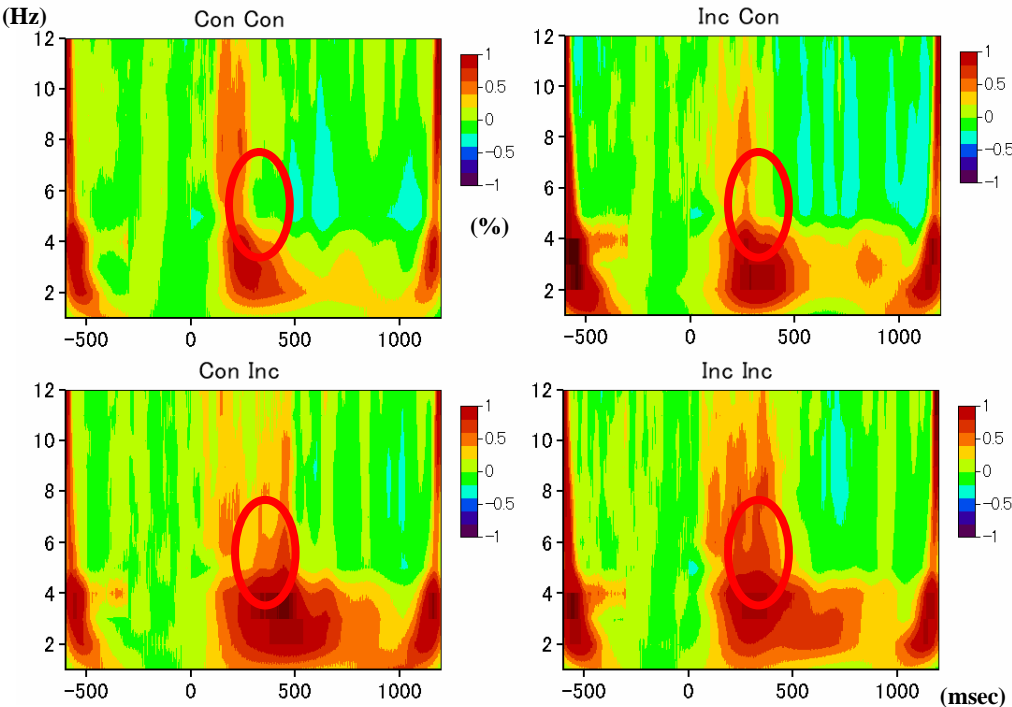
The significant interaction between condition and proportion ( $F(1,11)=7.69, p < .05$ ), which indicated the larger GBR for congruent condition only in 80% congruent block ( $p < .05$ ).

Also post-hoc analysis revealed the proportion effect for congruent is opposite for incongruent ( $p < .05$  for both).

Congruency Effect could be affected by top-down modulation (Expectation of the next trial), GBR is the neural response of the top-down modulation on multimodal integration.



# EEG Results



The significant main effect of condition ( $F(1,11)=11.20$ ,  $p < .01$ ), which indicated the larger Theta band oscillation for incongruent condition ( $p < .01$ ).

No significant interaction between condition and proportion ( $F(1,11)=.71$ , n.s.).

Also post-hoc analysis revealed that the theta power differences between congruent and incongruent condition were not changed by the proportion.

Theta band oscillation was not affected by the expectancy of the stimuli by the proportion, which suggests this component could reflect bottom-up sensory process.

