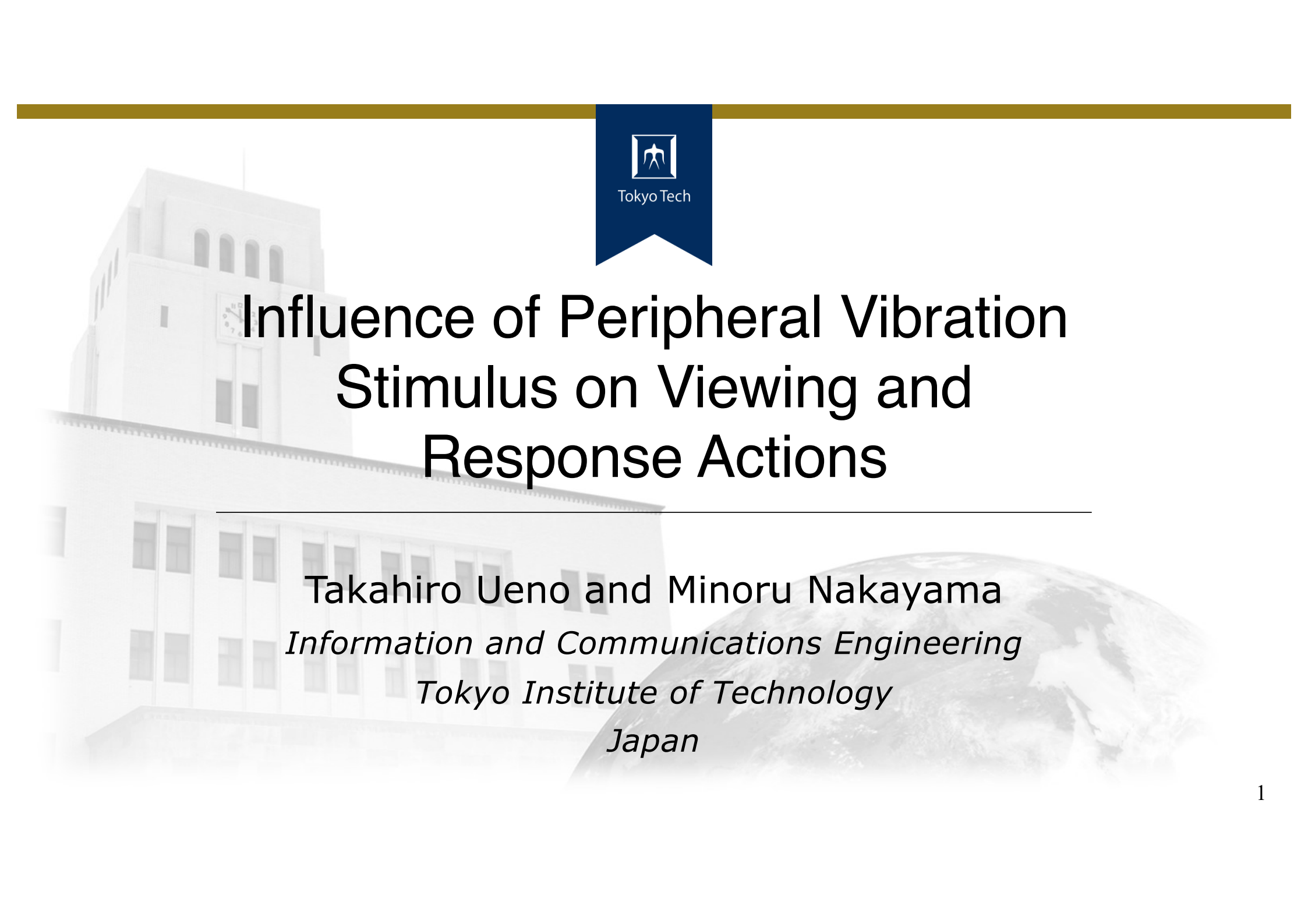

Influence of Peripheral Vibration Stimulus on Viewing and Response Actions

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Background

- Peripheral fields of vision
  - During the design of information displays [*alert*, *pops*], the properties have been considered such as PC desktop, HMD setting, etc.
- Visual perception ability between the peripheral and central fields should be examined.
  - Difference in perception ability exists between upper and lower fields of vision.
- Visual attention may be measured using eye movements, in particular microsaccades as an index of attention

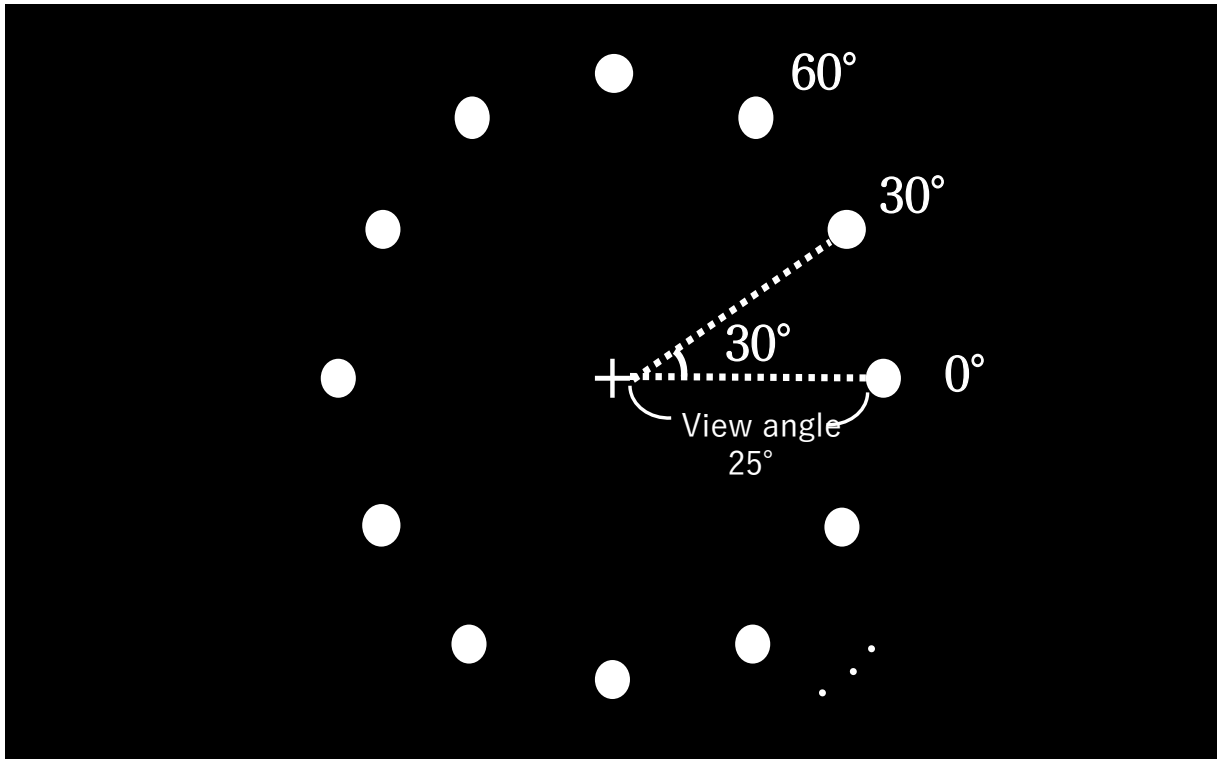
Purpose

- Observing eye movements during an experiment which provides a dual task, paying attention to the central and peripheral regions

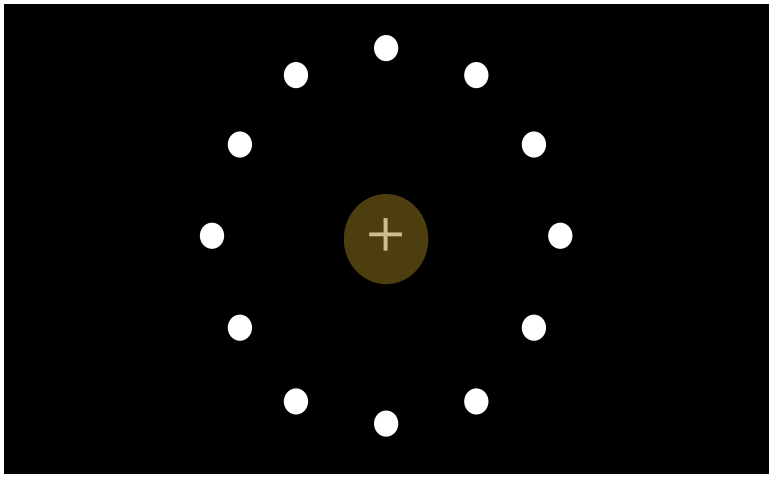
- The relationship between peripheral vibration perception performance and eye movement behaviour during viewing
  - To examine the ability to respond to a task at the central region while paying attention to the peripheral field of vision

- The changes of microsaccade (MS) frequency are evaluated as a response to the level of visual attention

Visual stimulus

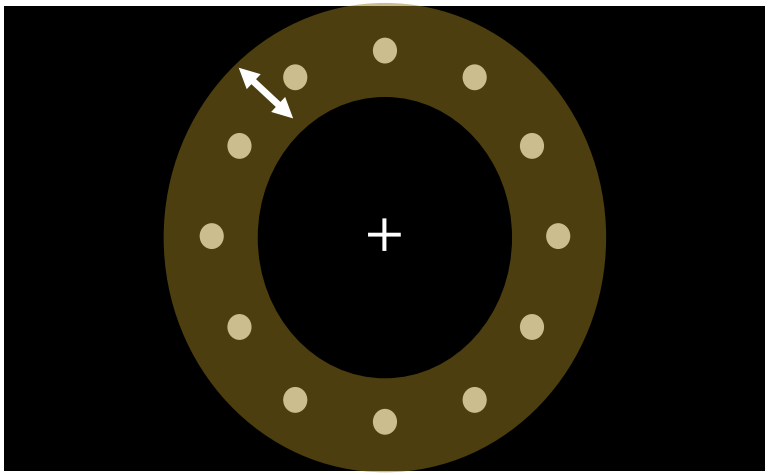


Two types of viewing task



The central vision task

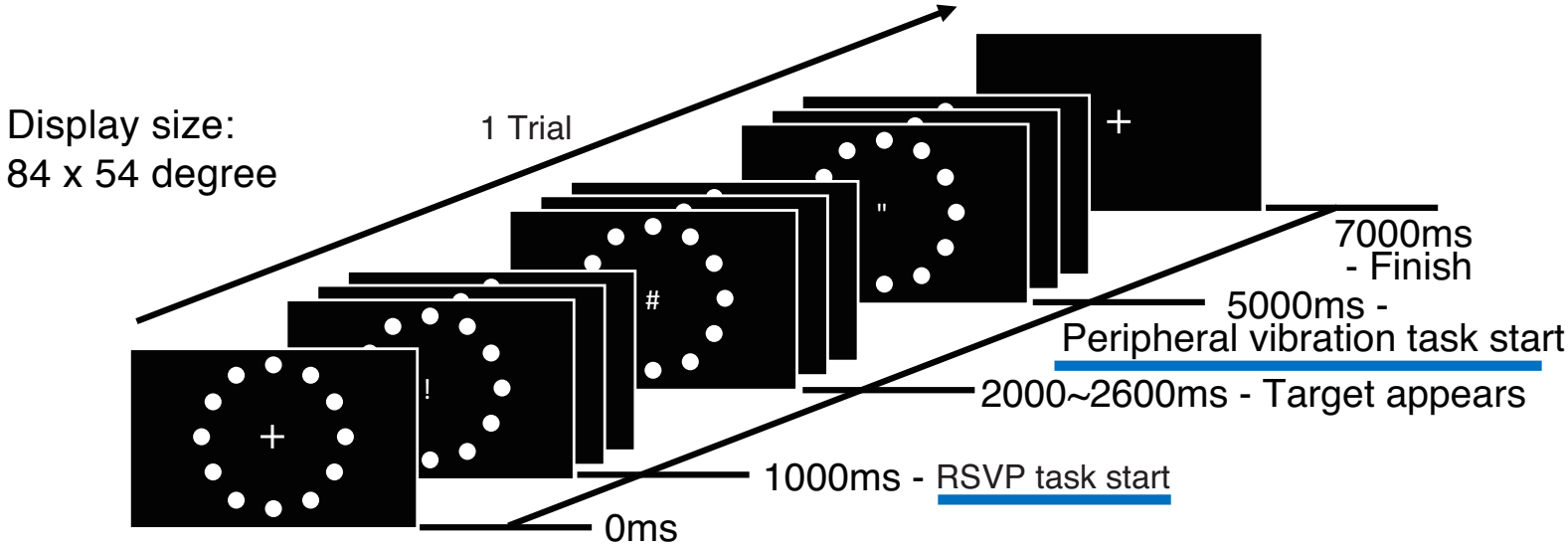
RSVP task:
Reporting numerals from sequence of alphabets



The peripheral vision task

Vibration Freq:
5, 10, 15, 20 and 25Hz
Detect and response the vibrated dot

Experimental procedure



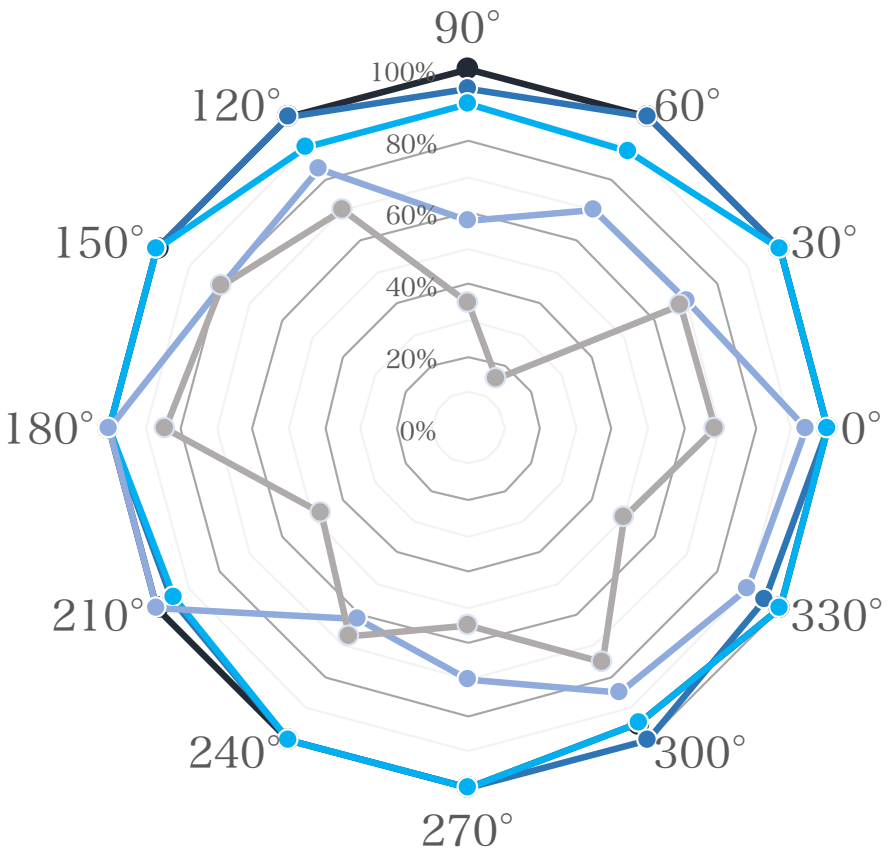
Experimental design: 12 directions x 5 levels of Freq x 2 trials (in total 120 trials)

Eye tracking: sampled at 400Hz (Arrington BCU400) for left eye

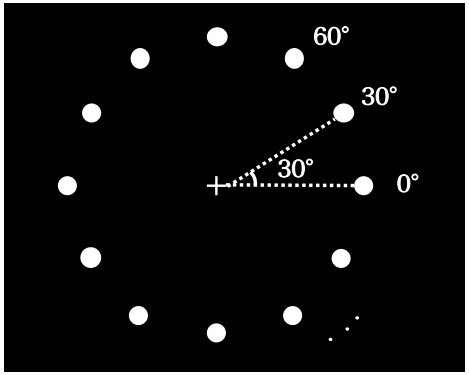
Observer: 10 participants (21-22 aged) joined and provided their written consent

Detection rates for vibration

Peripheral visual attention



Mean detection rates for each direction

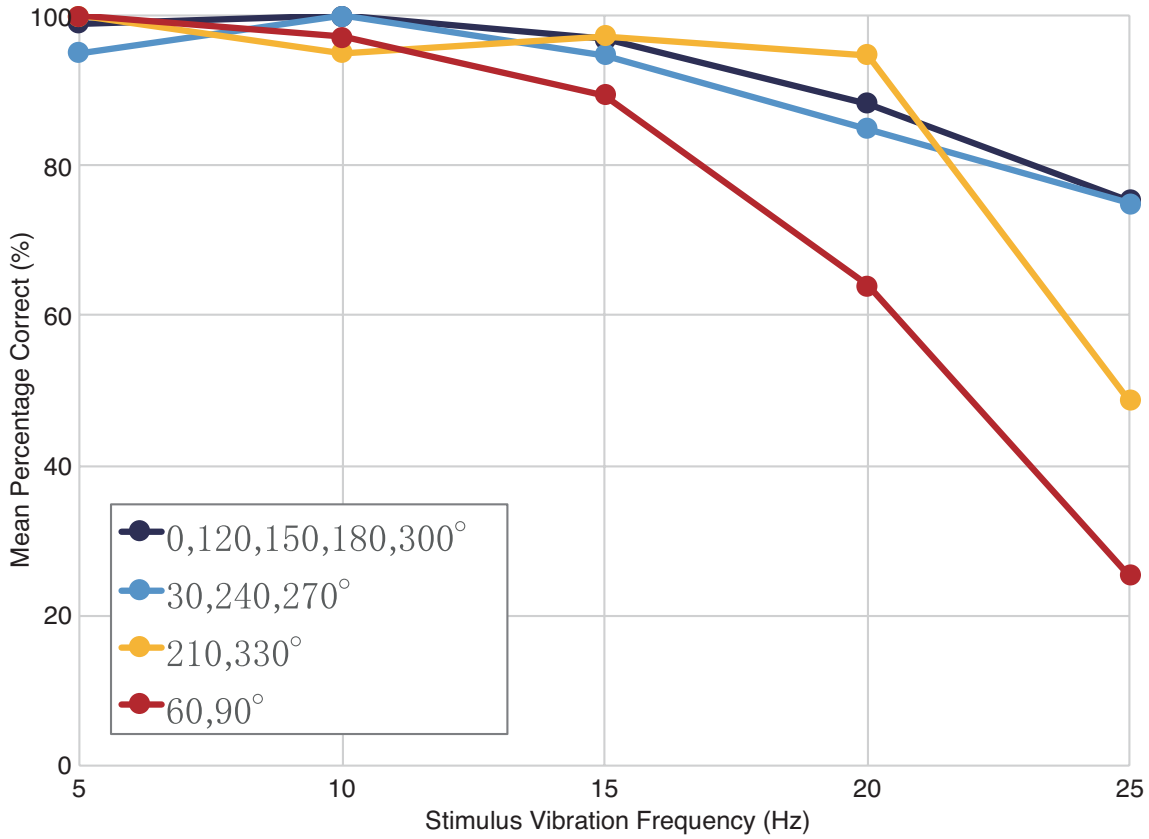


Stimulus locations

5Hz
10Hz
15Hz
20Hz
25Hz

Mean percentage corrects

4 Clusters are extracted using cluster analysis



change with vibration frequency

Hierarchical Bayesian modelling

- Estimate each effectiveness
  - Responses: *Y* binary data is observed as a Bernoulli distribution

$$Y \sim Bernoulli\ (\theta)$$

  - The percentage correct θ is hypothesized

$$logit\ (\theta) = \beta_1 \times F + PO + rID + rTR$$

$$\text{(Correctness)} = \begin{pmatrix} Intercept \\ \times \\ Frequency \end{pmatrix} + \begin{pmatrix} Effect\ of \\ Direction \end{pmatrix} + \begin{pmatrix} Individual \\ effect \end{pmatrix} + \begin{pmatrix} Order\ effect \\ stimuli\ onset \end{pmatrix}$$

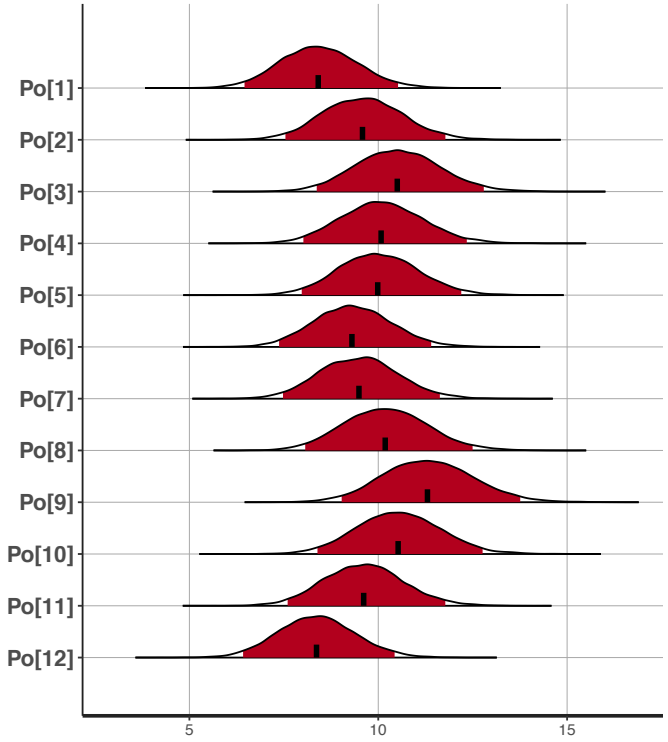
  - Experimental factors can be noted as follows

$$PO_i \sim Normal\ (PO_{i-1}, sPO)\ (i = 1, 2, \ldots, 12)$$
$$rID_j \sim Normal\ (0, sID)\ (j = 1, 2, \ldots, 10)$$
$$rTR_k \sim Normal\ (rTR_{k-1}, sTr)\ (k = 1, 2, \ldots, 120)$$

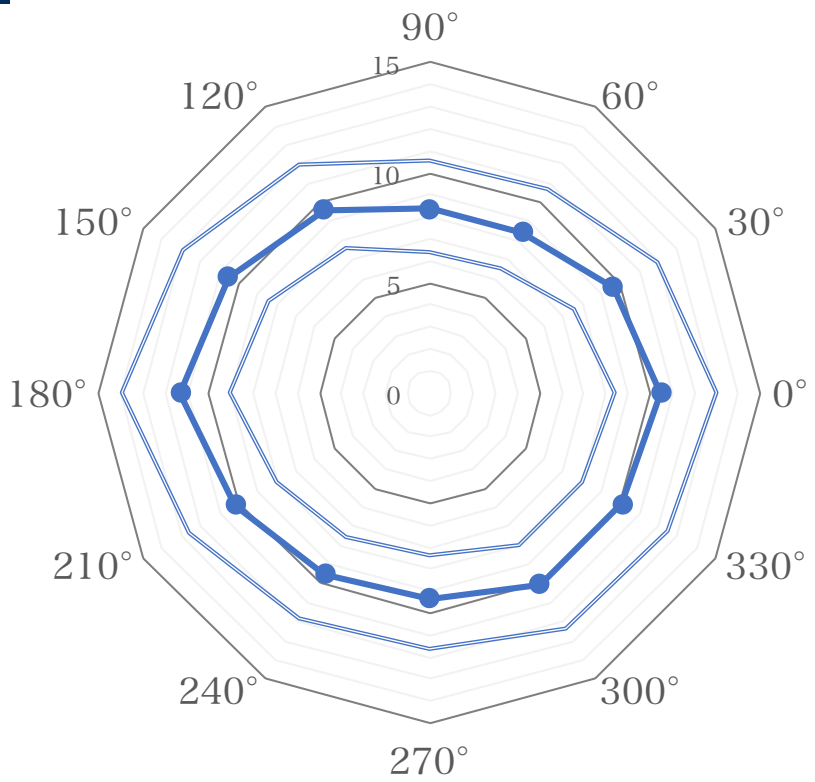
- All parameters are estimated using MCMC technique

Directional factor estimation

$$logit(\theta) = \beta_1 \times F + \boldsymbol{PO} + rID + rTR$$



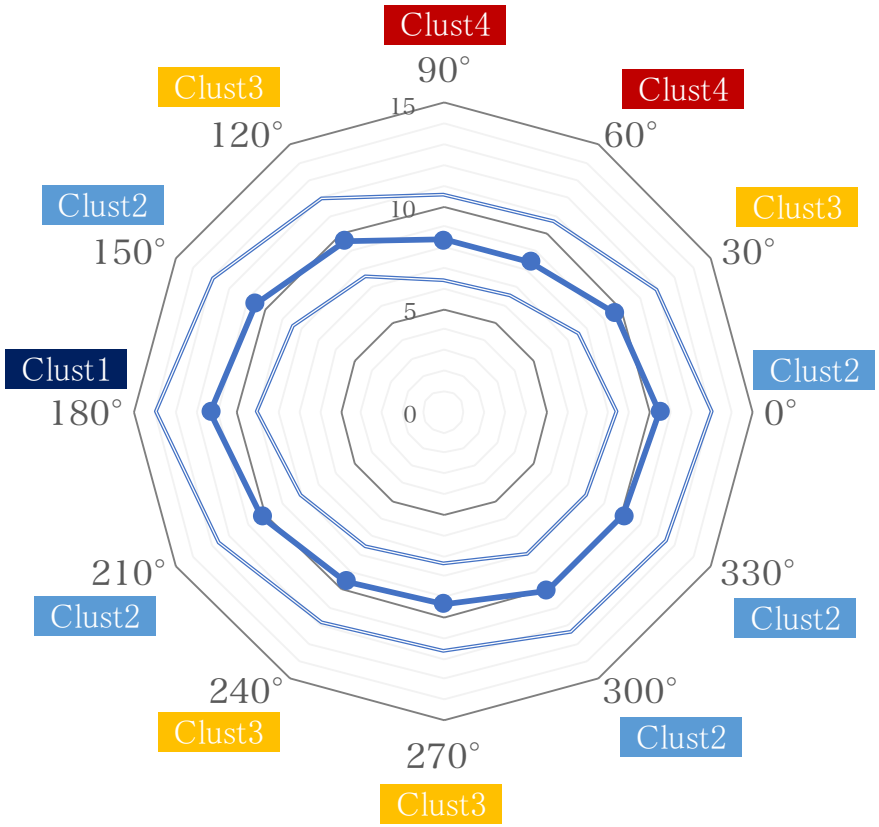
Directional estimation distributions

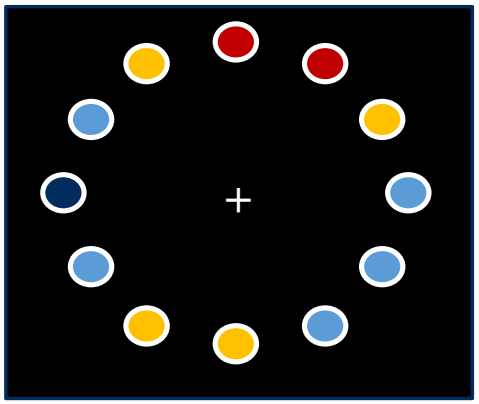


Solid line：Mean, dotted line: 95%

Posterior distribution

- Parameters for directional angle *PO*

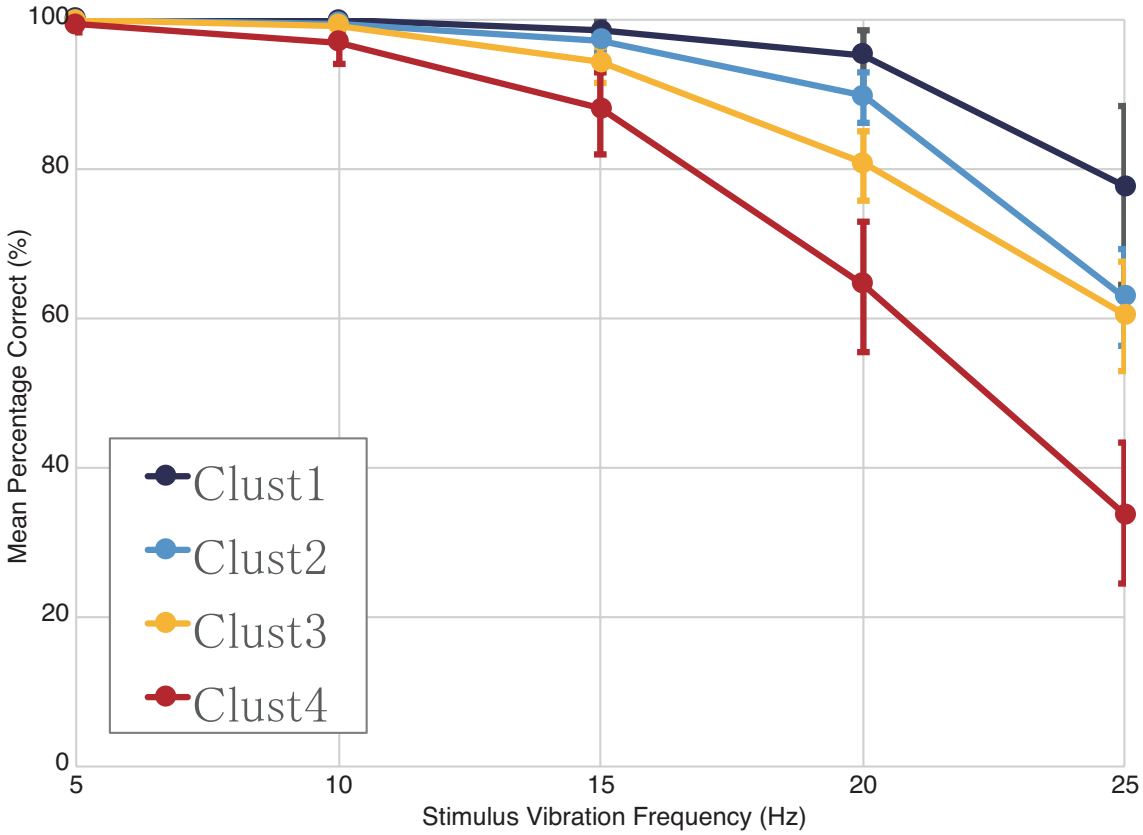




Clusters	Detection Ability
Clust1	**High**
Clust2	**Slightly high**
Clust3	**Slightly low**
Clust4	**Low**

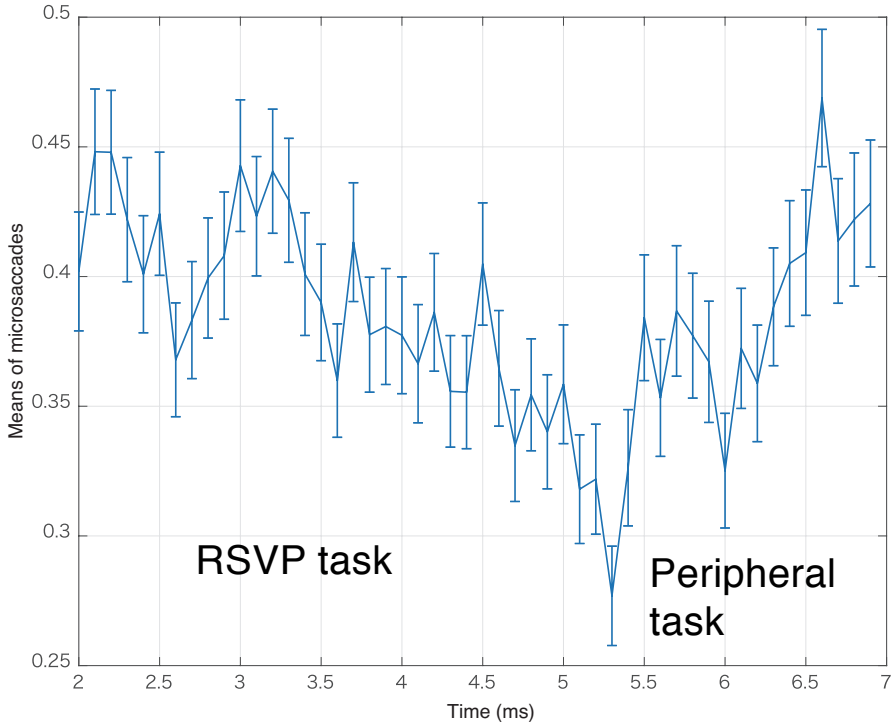
Estimated Frequency dependency

- Updated result using estimations



Estimation attentional levels

- Analysis of microsaccades (MSs)
  - MSs extracted using MS toolbox (2015)



Noise influence?

Extracting MSs frequency

- Microsaccade frequency Y_t
  - With white noise μ, measuring error ε

$$\mu_{t+1} = \mu_t + \eta_t, \quad \eta_t \sim Normal\left(0, \sigma_\eta^2\right)$$

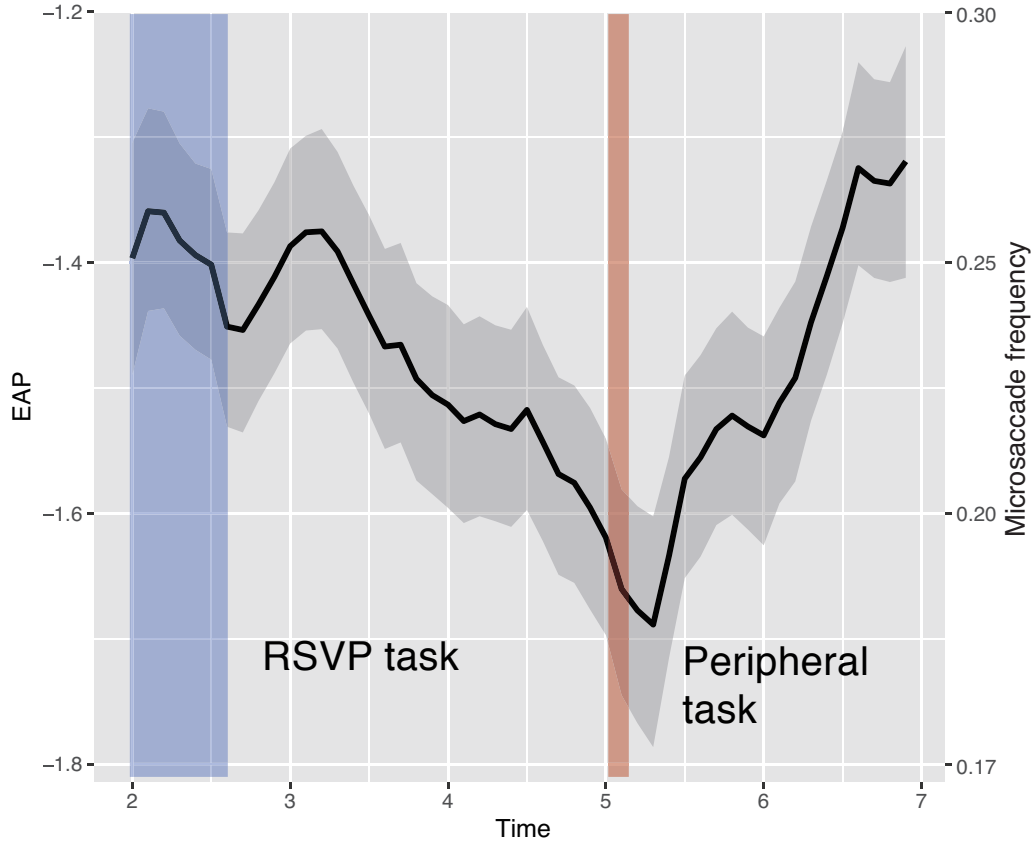
$$log(y_t) = \mu_t + \varepsilon_t, \quad \varepsilon_t \sim Normal\left(0, \sigma_\varepsilon^2\right)$$

$$Y_t \sim Poisson\left(y_t\right)$$

  - Microsaccade rate is estimated as EAP, expected a posterior measure using MCMC technique

Estimated MS frequency

- Estimates with 95% confidential intervals



Summary

- EM and MSs were analysed to evaluate both responses and attentional behaviour

- Perceptional performance during peripheral vibration
  - The regions were classified into 4 fields
  - Upper and lower fields are relatively lower
- Frequency of temporal MSs
  - May suggest latent attention
  - The effect was significant after the appearance of the stimuli
- *The effect of hierarchical estimation technique has confirmed*

Thank You for your kind attention