Introduction to Cognitive Neuroscience

Spatial Attention Decorrelates Intrinsic Activity Fluctuations in Macaque Area V4

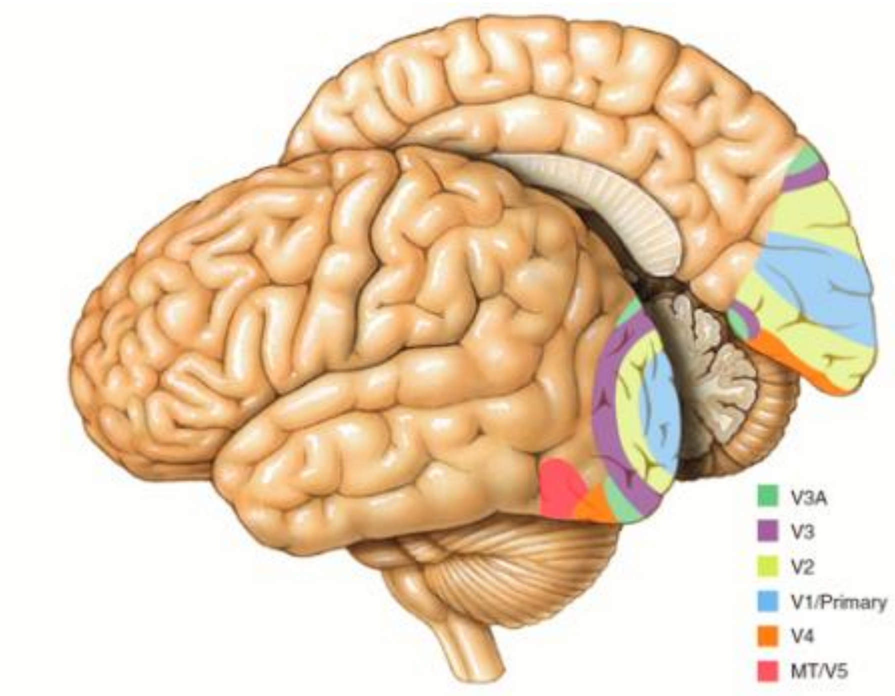
Presented by :

Arefe Farahmandi

Farzaneh Taleb

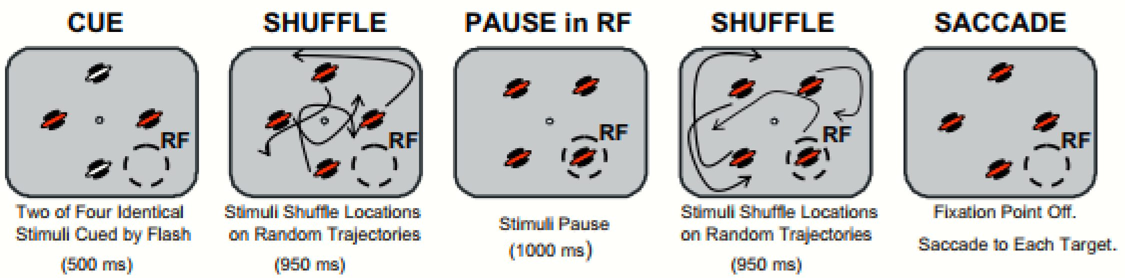
Attention

- Top down attention
    - ✓ Spatial attention
- Buttom- up attention



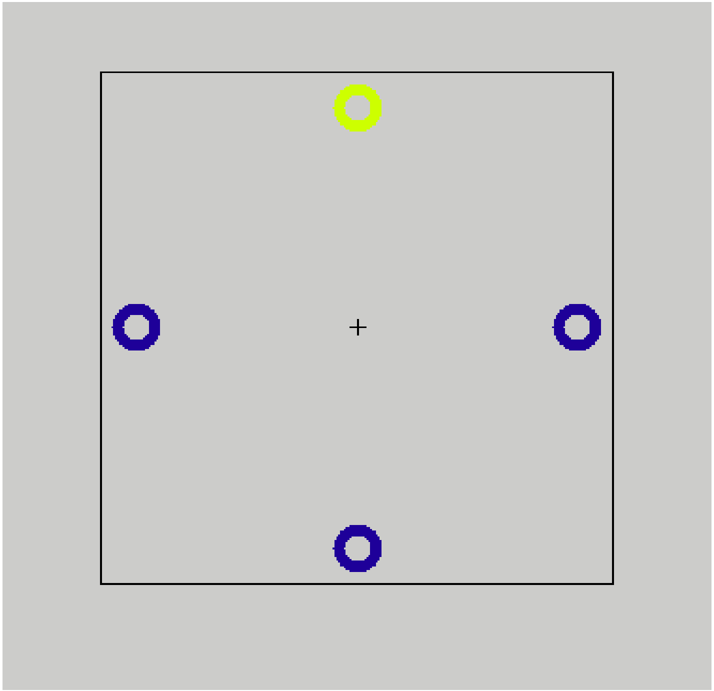
Attention improves our ability to **detect** and **discriminate** the features of sensory stimuli.

Task

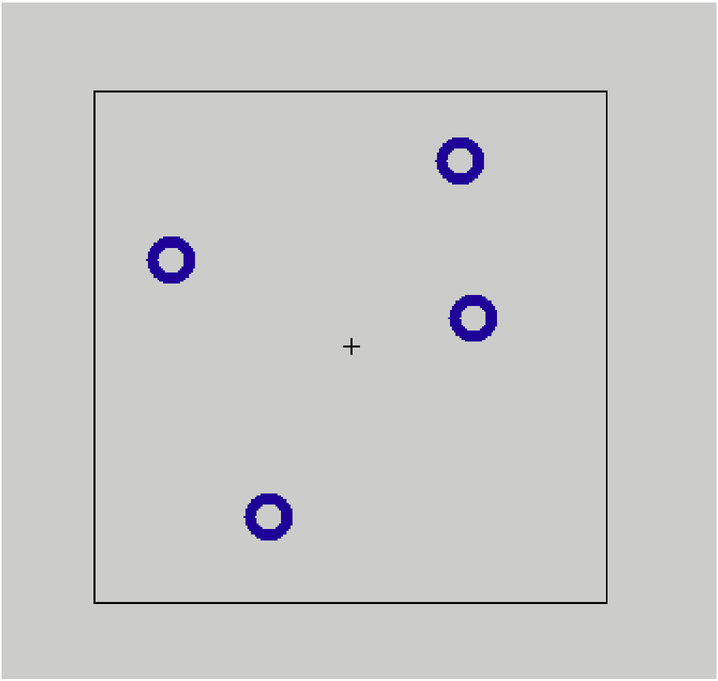


- Attend in
- Attend out

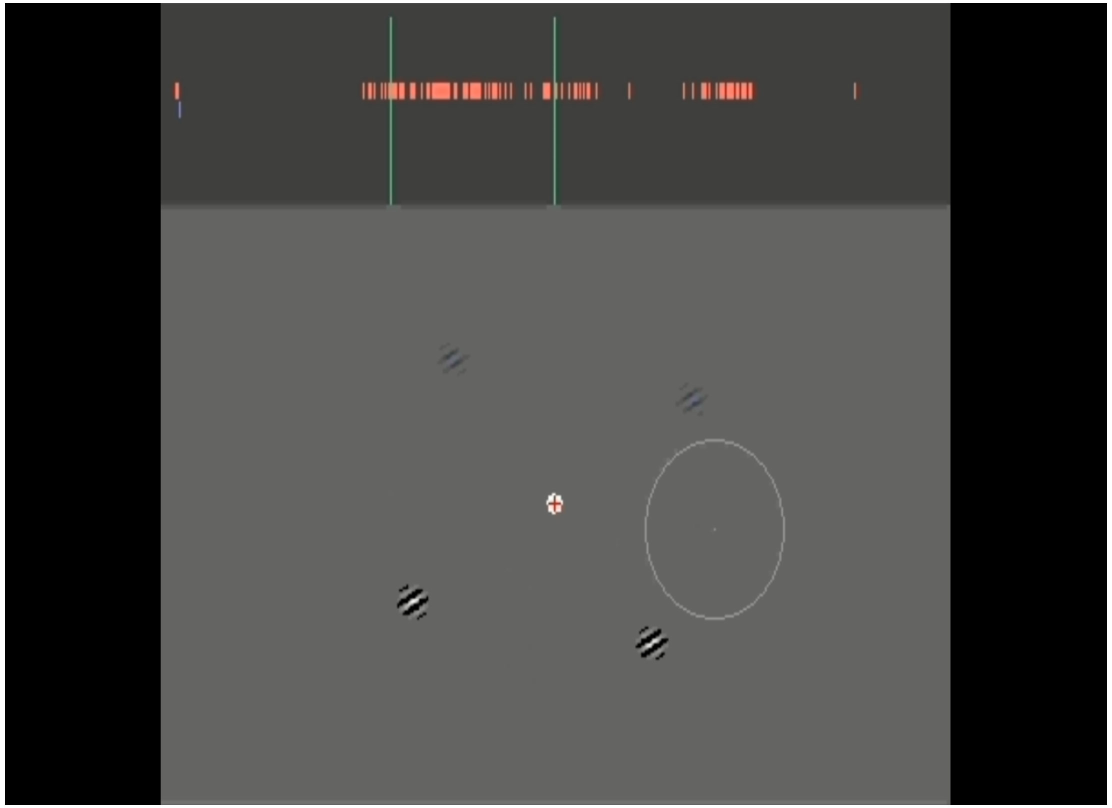
Cue



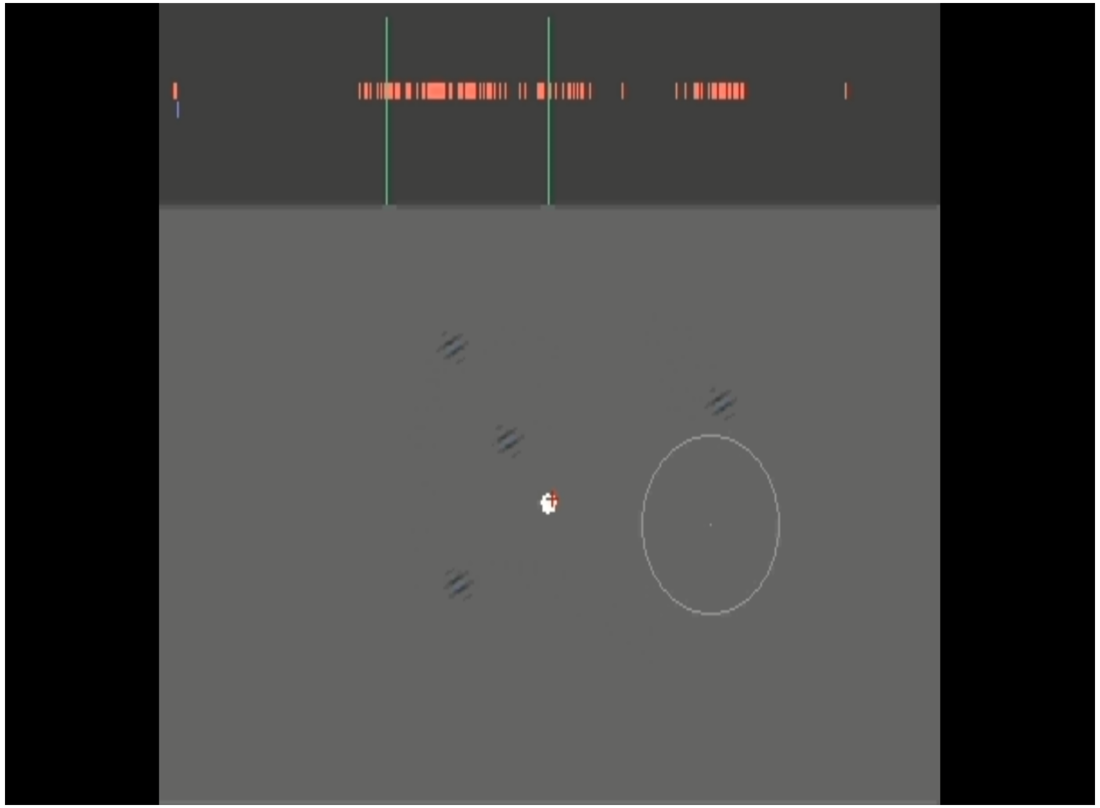
Shuffle



CUE

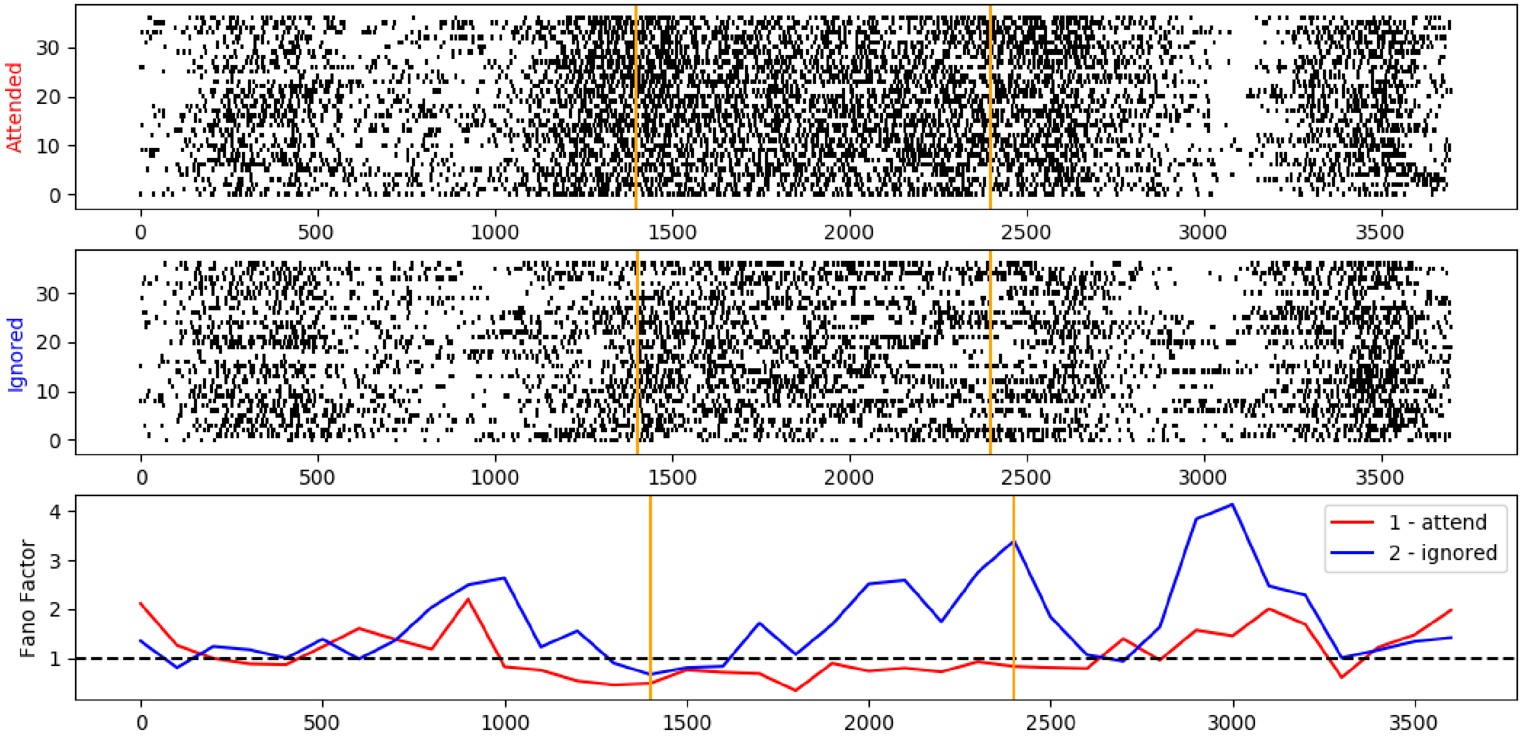


SHUFFLE

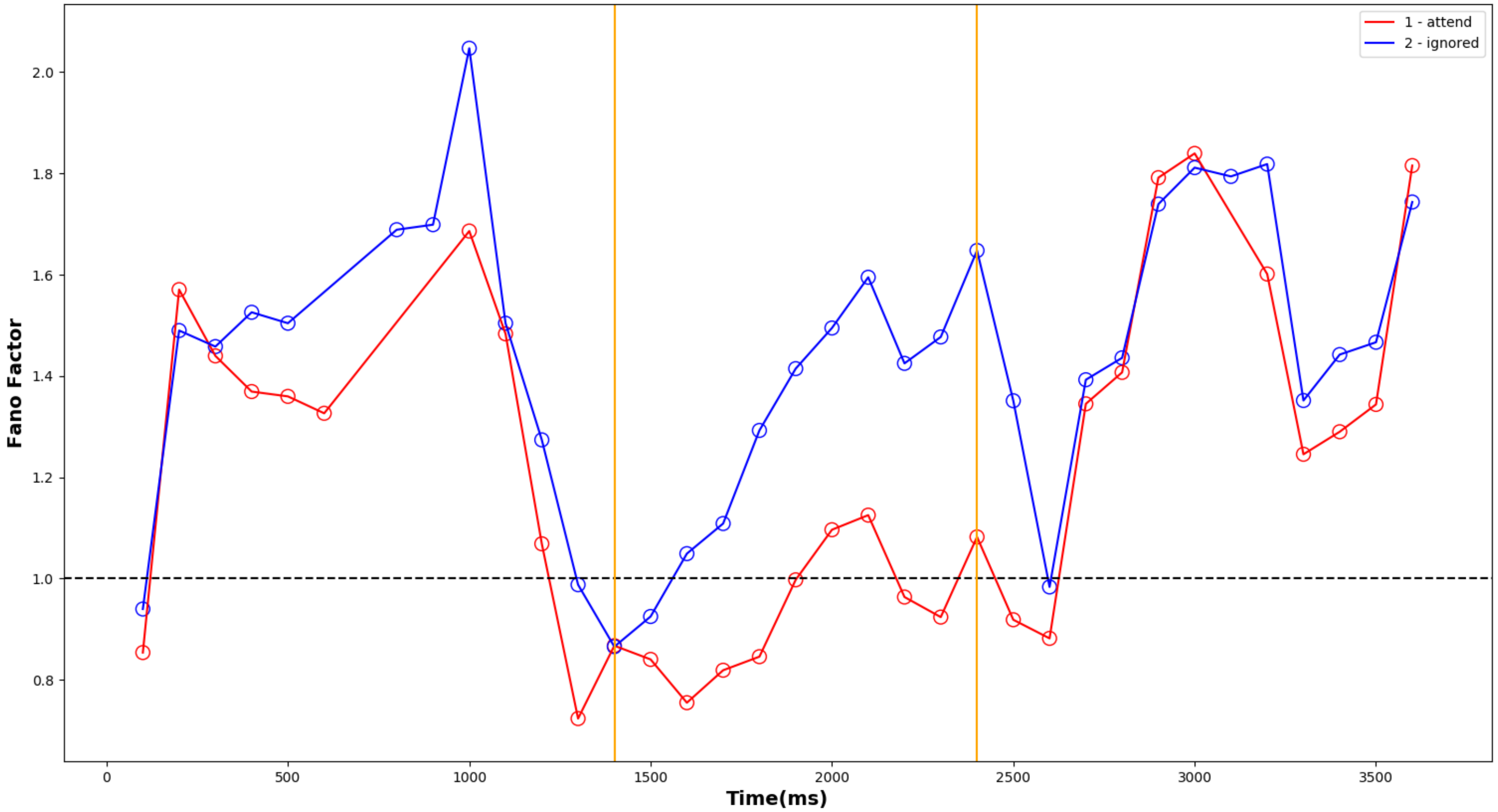


Firing Rate

$$\text{Fano factor} = \frac{\text{ratio of spike count variance}}{\text{mean spike count}}$$



Averaged Fano Factor



Analysis

response variability reflected :

1- independent fluctuations in responses of individual neurons?

2- represents a source of correlated noise across network ?

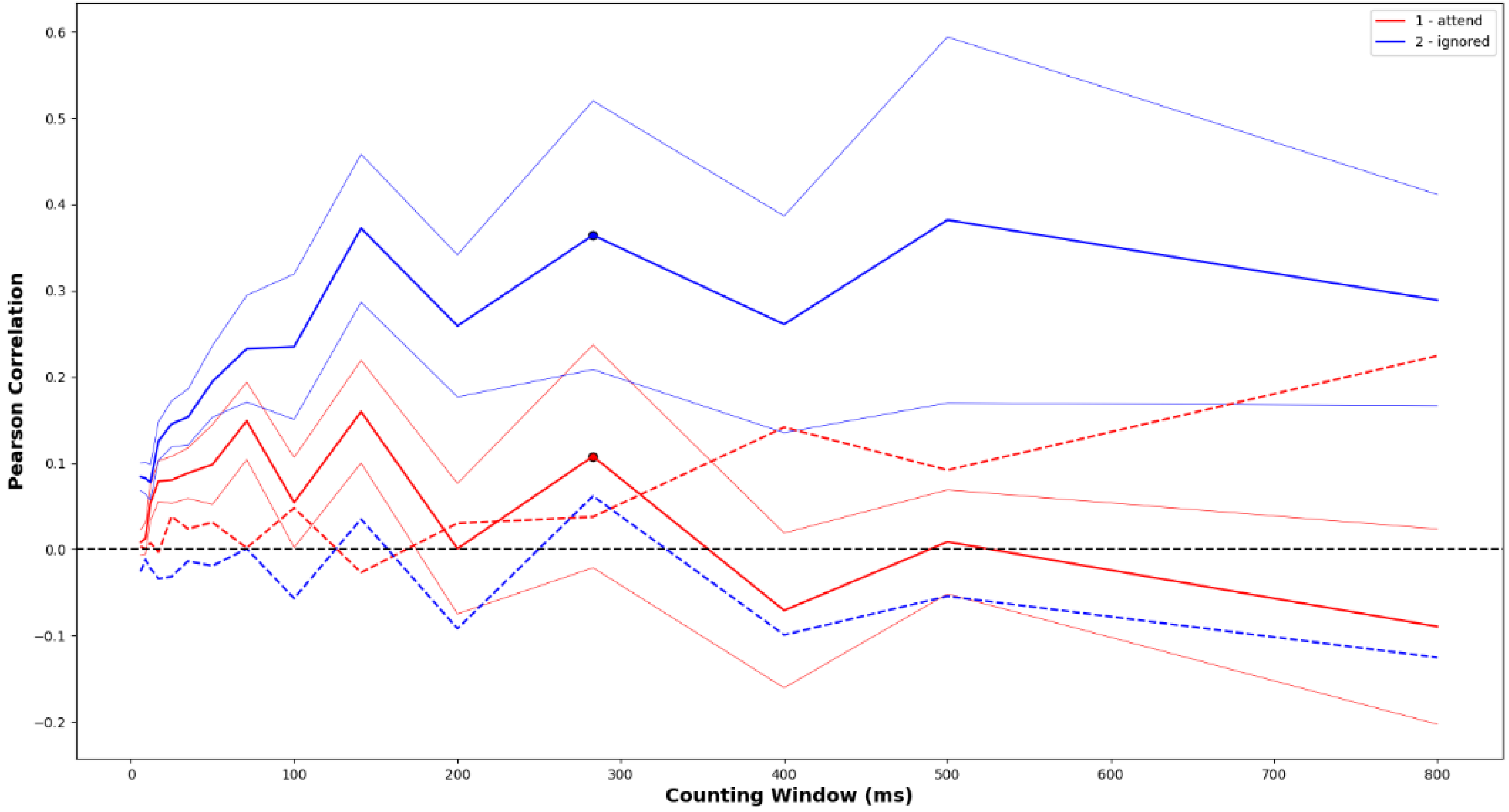
Spike – spike Coherence analysis

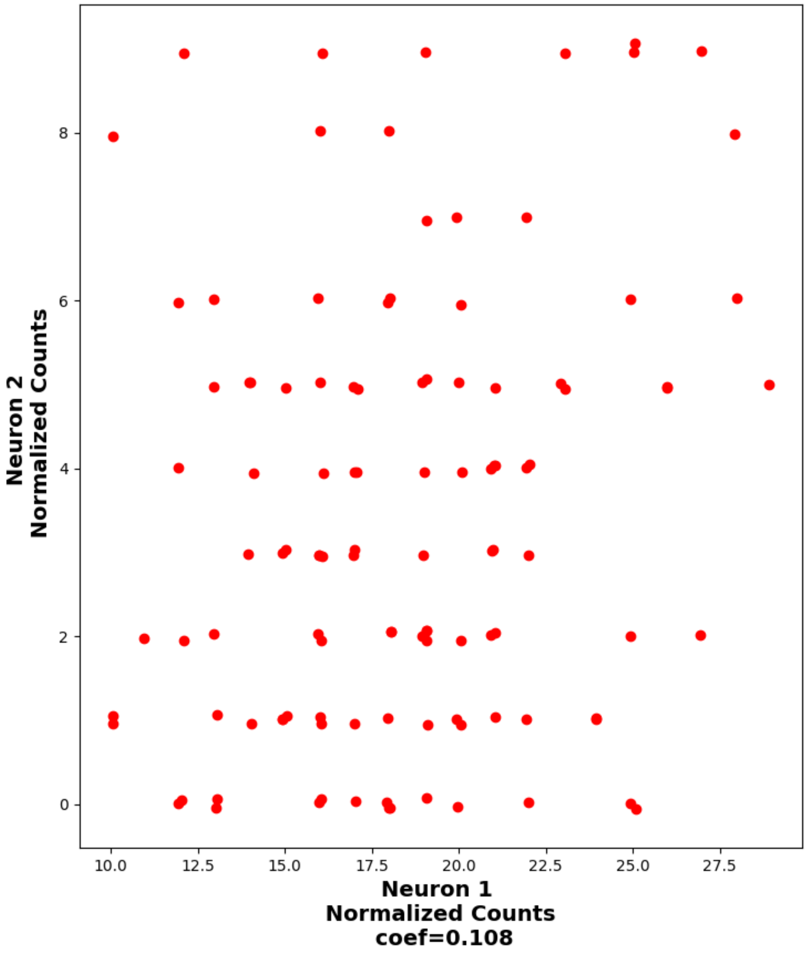
Multi-tapers coherence

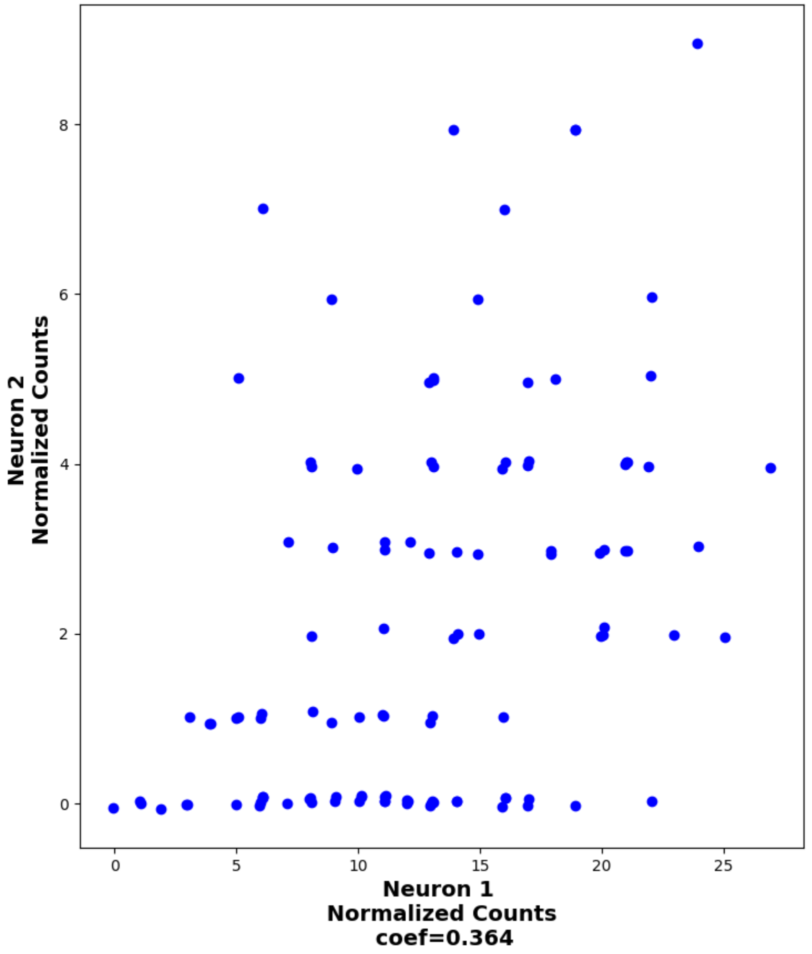
Correlation analysis

Pearson correlation

2. Pearson correlation




Neuron 2
Normalized Counts
0
2
4
6
8
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
Neuron 1
Normalized Counts
coef=0.108


Neuron 2
Normalized Counts
0
2
4
6
8
0
5
10
15
20
25
Neuron 1
Normalized Counts
coef=0.364

3. Spike-to-spike Coherence

$$x_t = \int_{-1/2}^{1/2} \tilde{x}(f)\exp(2\pi i f t)\,df$$

$$S_X(f)\delta(f-f') = E[\tilde{x}^*(f)\tilde{x}(f')]$$

$$S_{XY}(f)\delta(f-f') = E[\tilde{x}^*(f)\tilde{y}(f')]$$

$$C_{XY}(f) = \frac{S_{XY}(f)}{\sqrt{S_x(f)S_y(f)}}$$

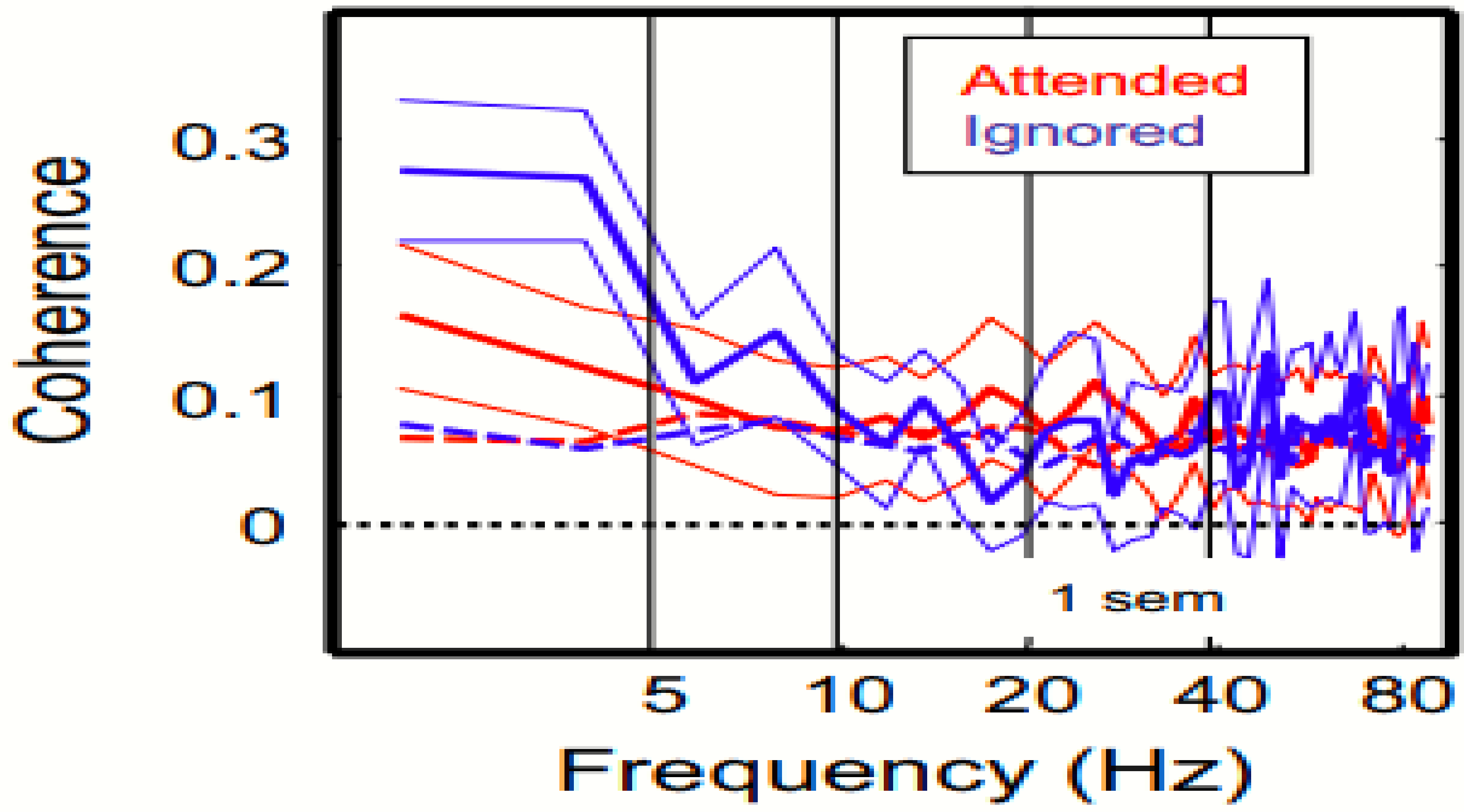
- MultiTaper coherence

$$S_{MT}(f) = \frac{1}{K}\sum_{k=1}^{K} |\tilde{x}_k(f)|^2$$

$$\tilde{x}_k(f) = \sum_{t=1}^{N} w_t(k) x_t \exp(-2\pi i f t)$$

$$C_{XY}(f) = \frac{\frac{1}{K}\sum_k \tilde{x}_k^*(f)\tilde{y}_k(f)}{\sqrt{S_x(f)S_y(f)}}$$

Plot coherence

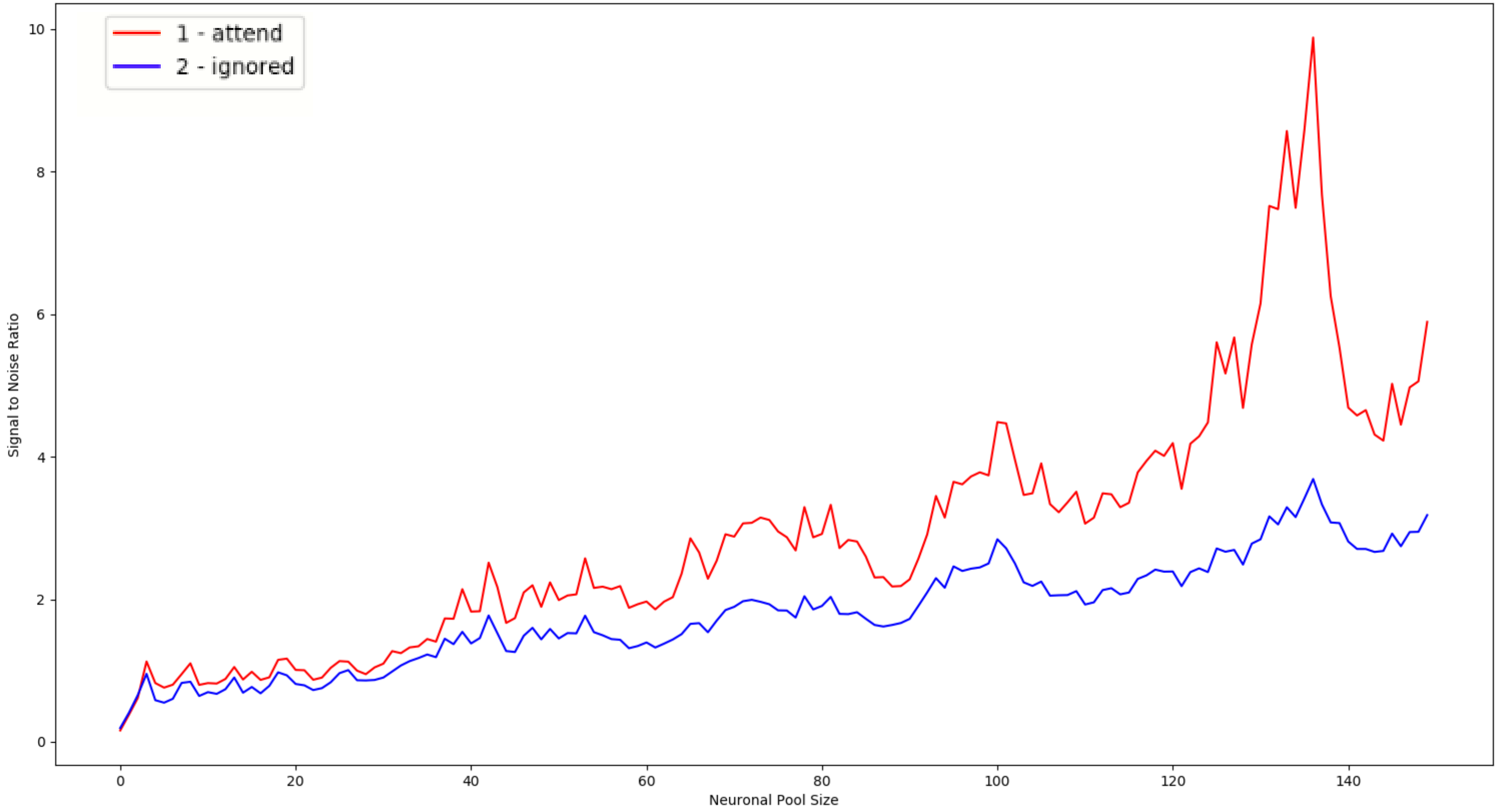


SNR

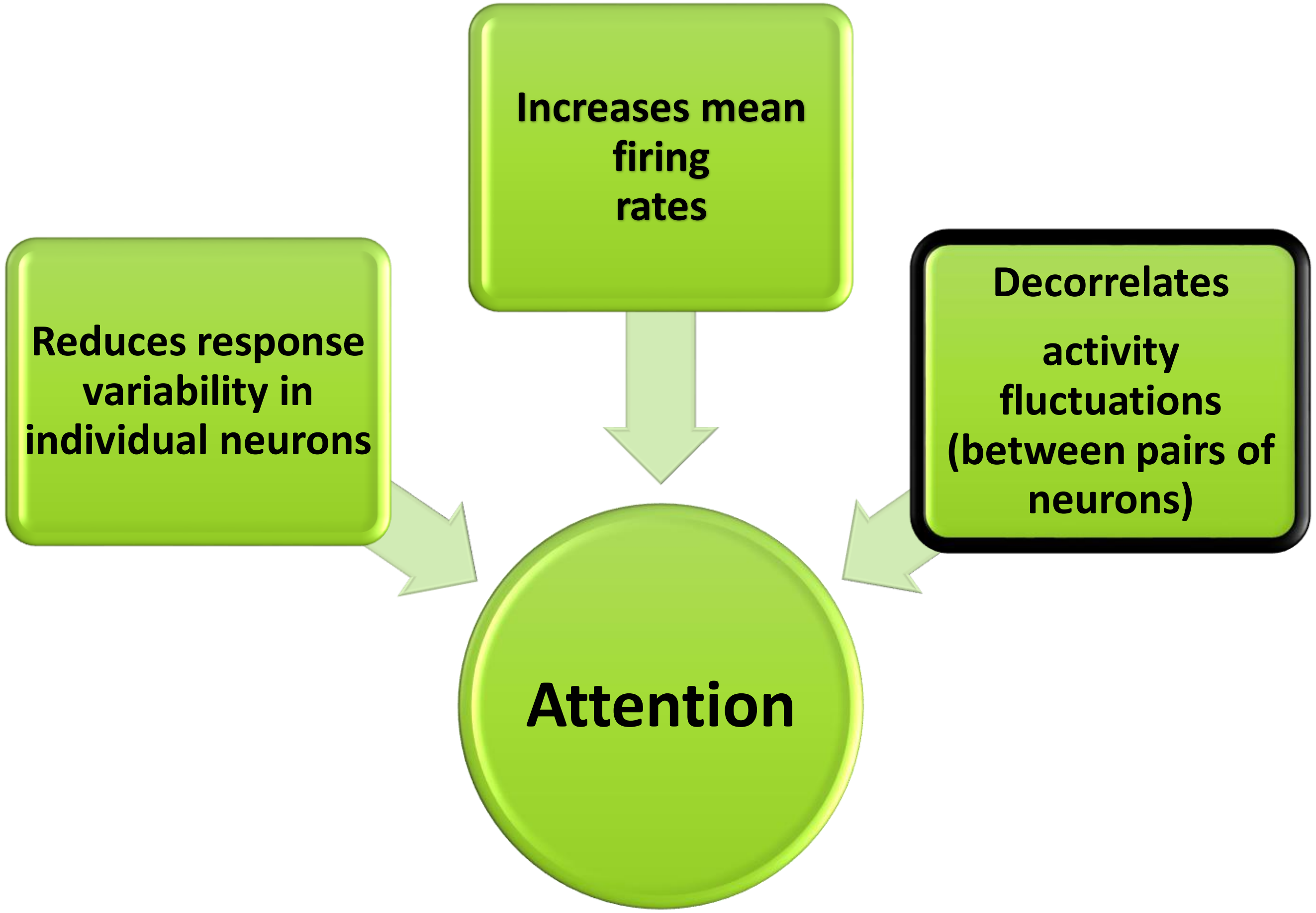
$$S/N = \left\langle \frac{\sum_1^M X_i}{\sigma_\Sigma} \right\rangle$$

$$= \frac{M\langle X \rangle}{\sqrt{\sum_{i=1}^M \sum_{j=1}^M \mathrm{Cov}\,[X_i, X_j]}}$$

$$= \frac{M\langle X \rangle}{\sqrt{M\sigma^2 + M(M-1)\bar{r}\sigma^2}}$$



Conclusion


Increases mean firing rates
Reduces response variability in individual neurons
Decorrelates activity fluctuations (between pairs of neurons)
Attention

Thanks :)