INTRODUCTION TO STEADY STATE VISUAL EVOKED POTENTIAL (SSVEP)

Neuroimaging workshop
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OUTLINE

- EEG overview

-What is the SSVEP?

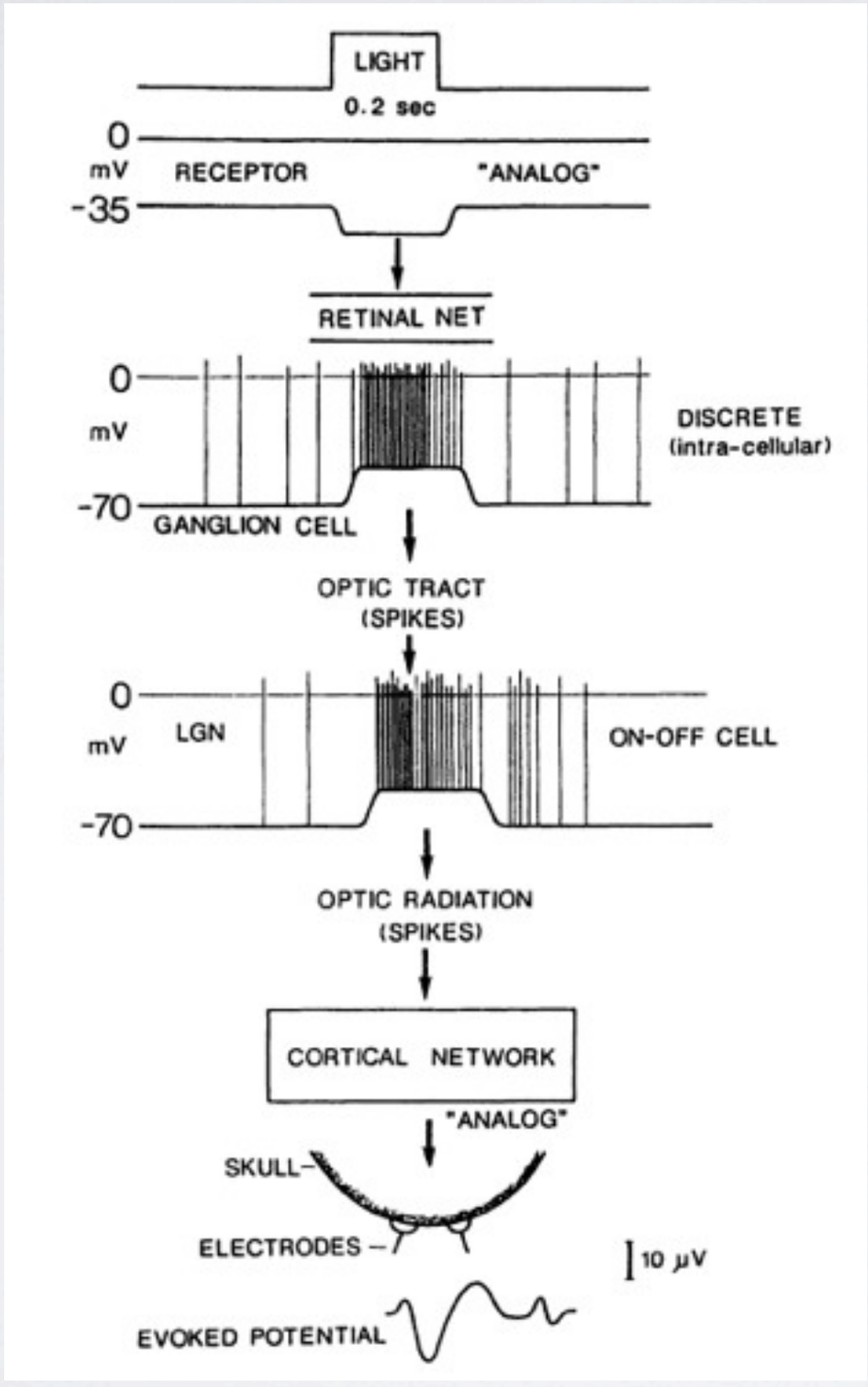
-How is it used to address neuroscience questions?

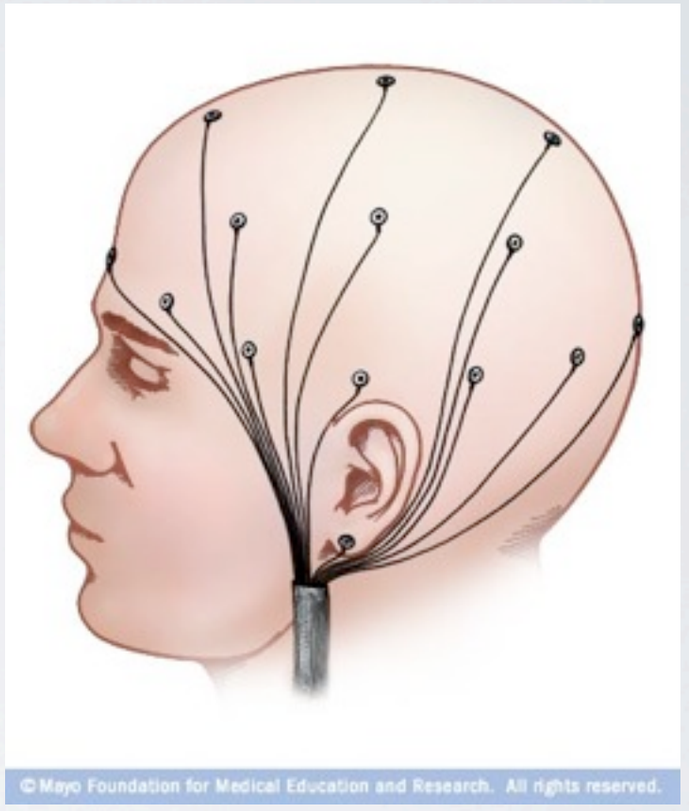
-How to design stimuli to obtain the SSVEP?

-What kind of analysis is necessary?

-Conclusions

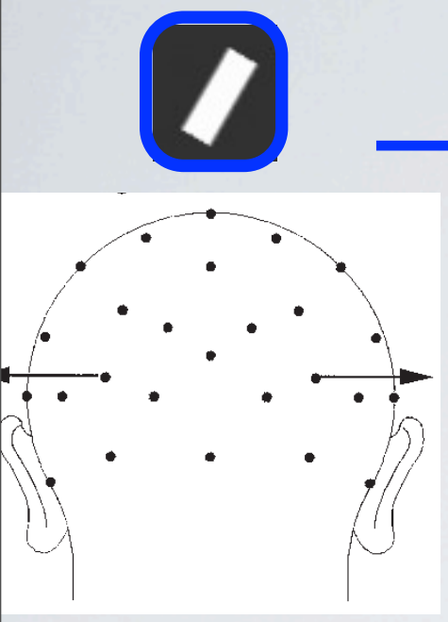
EEG REPRESENTS THE SUMMED ACTIVITY OF MANY NEURONS

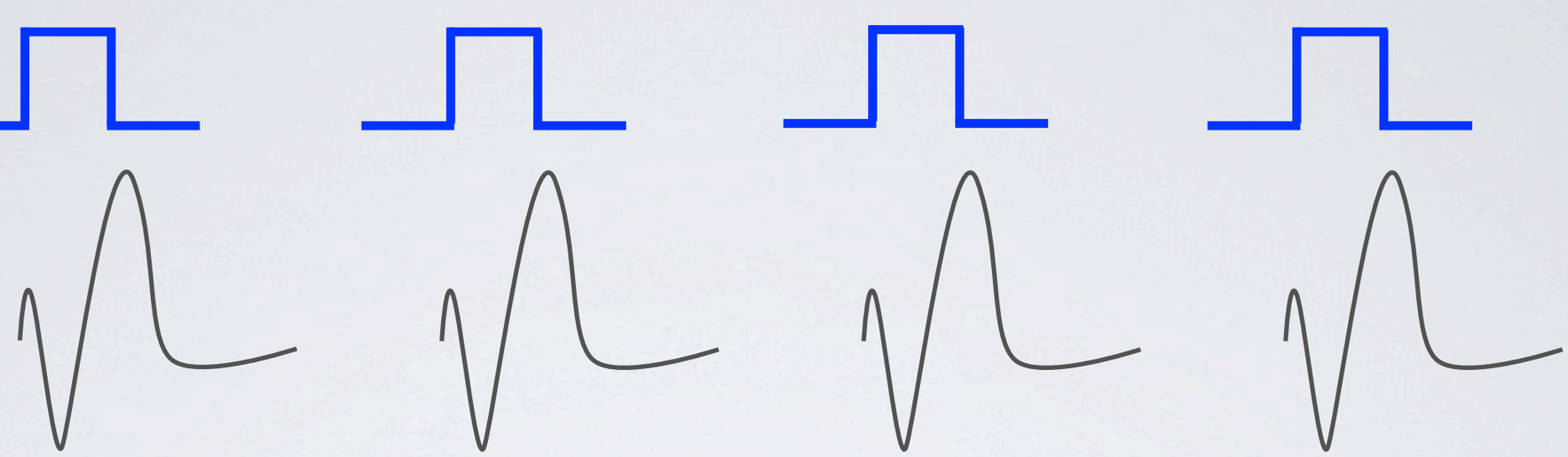


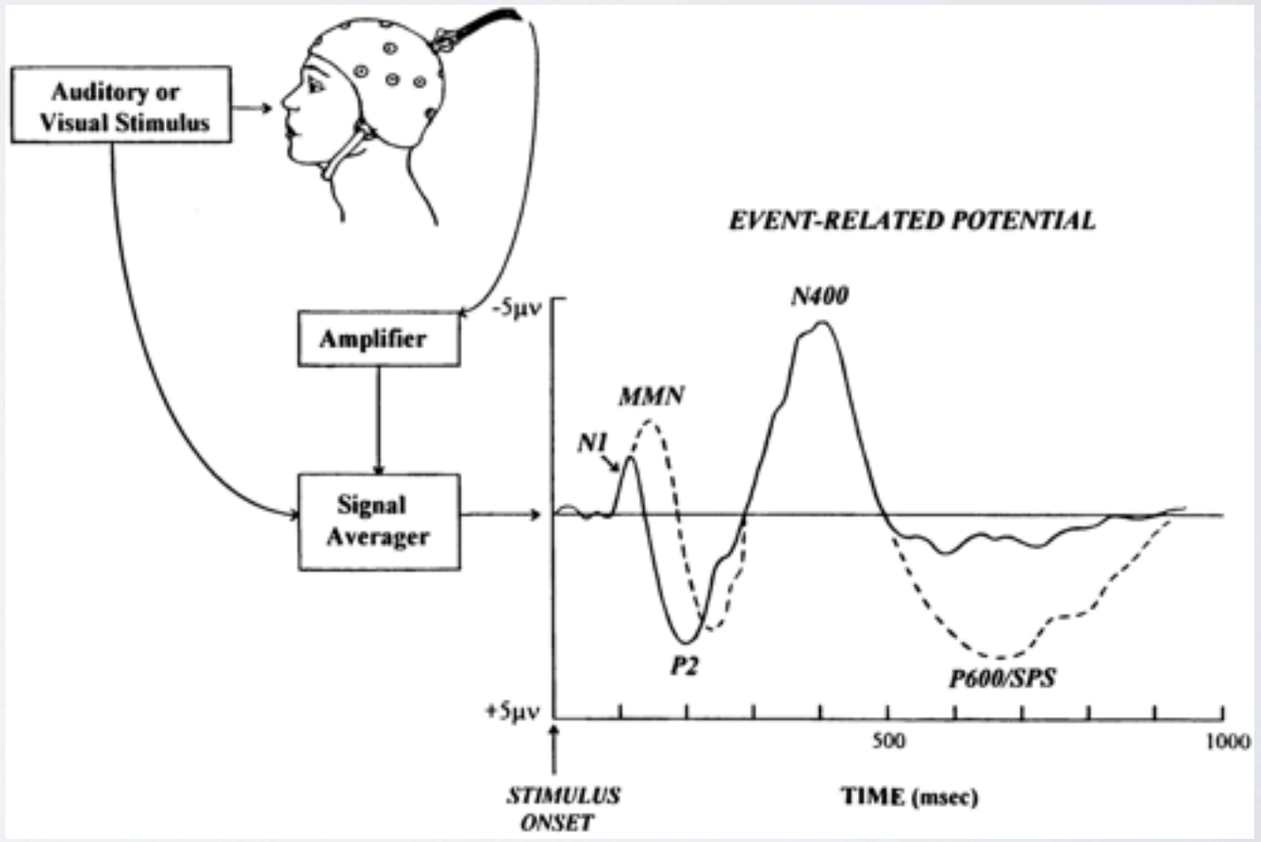


Machinery of the Mind - E Roy John (1990)

VISUAL EVOKED POTENTIAL

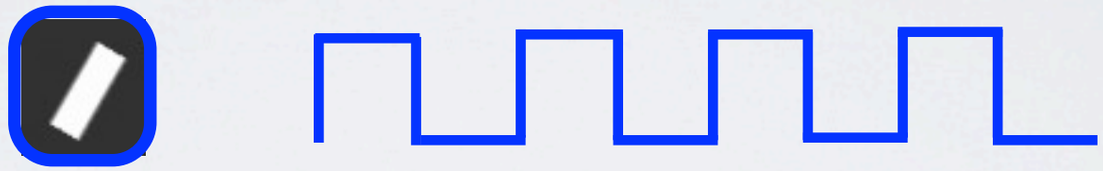


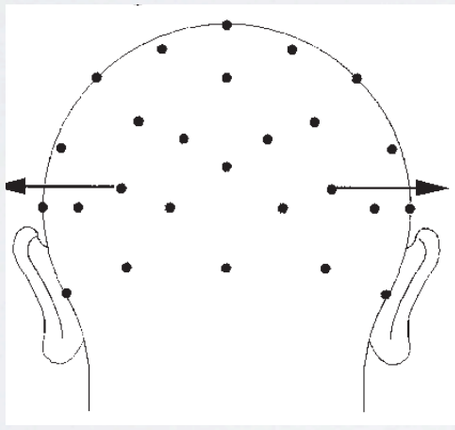


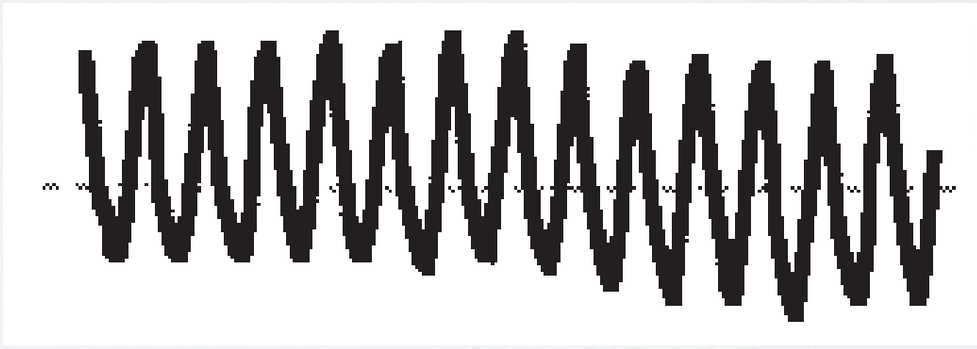


STEADY STATE VISUAL EVOKED POTENTIAL

modulation of the stimulation at a smaller time scale results in entrainment and a SSVEP

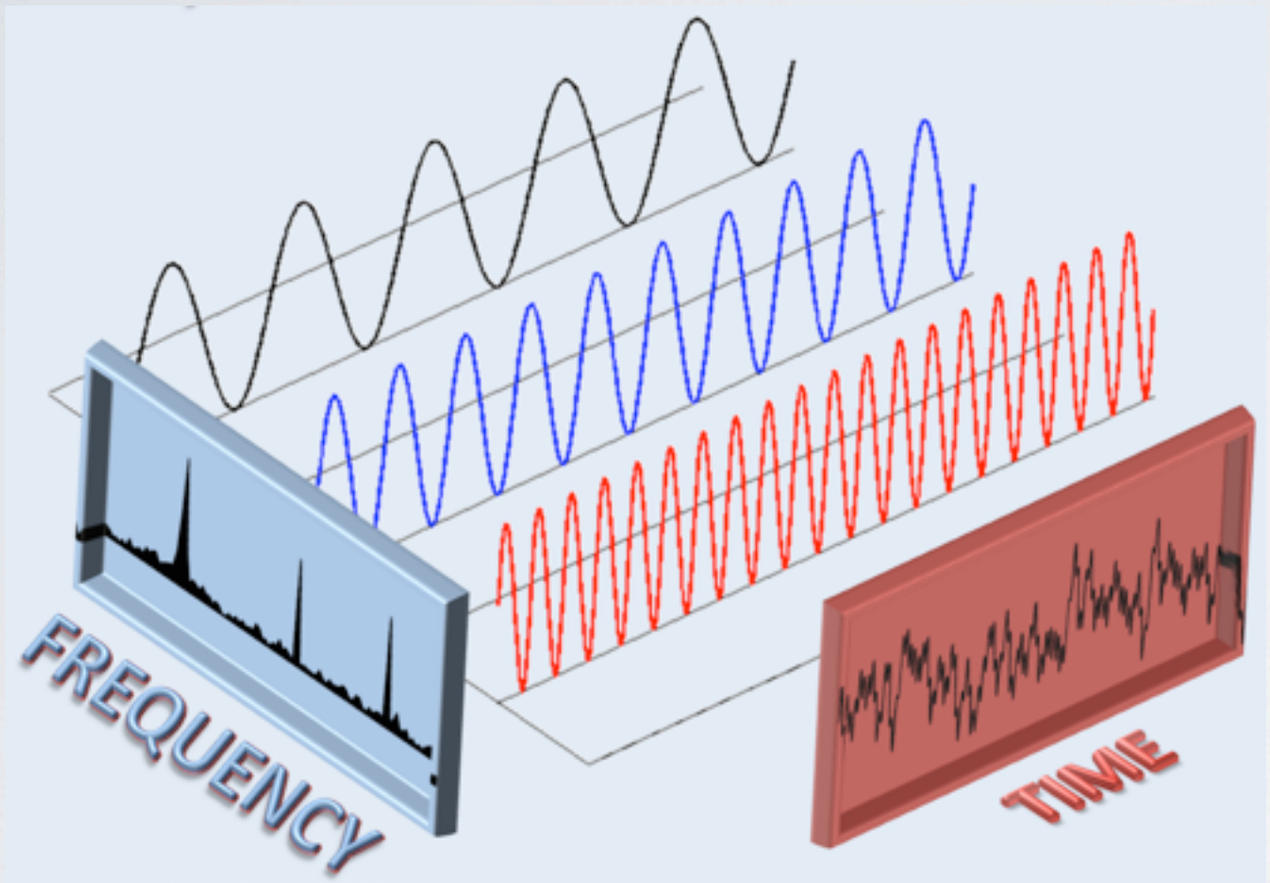






Muller et al. 1998

1 SLIDE INTRO TO FFT



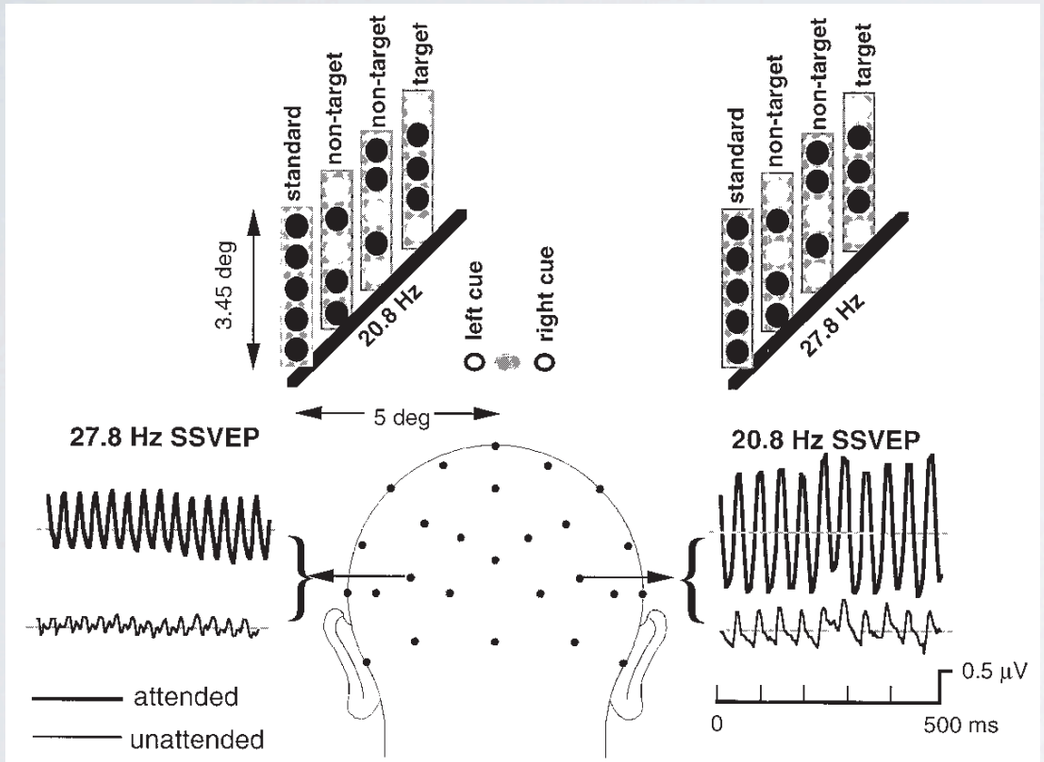
http://groups.csail.mit.edu/netmit/sFFT/

time domain signal

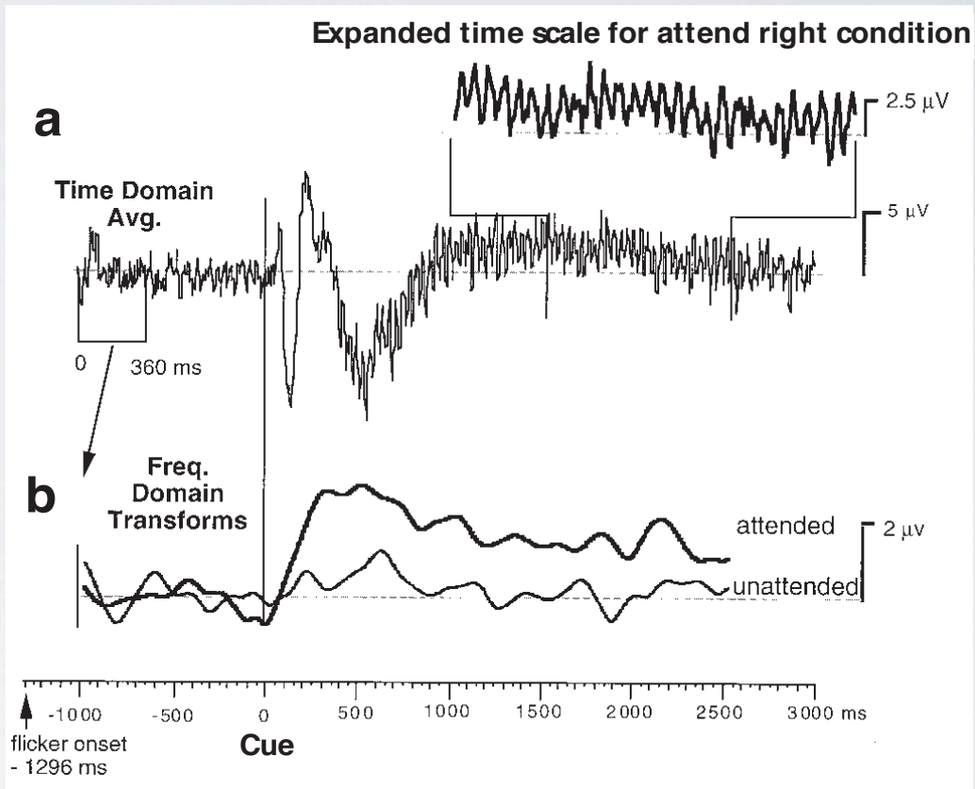
FFT

frequency domain signal

ATTENTION ENHANCES THE POWER OF THE SSVEP

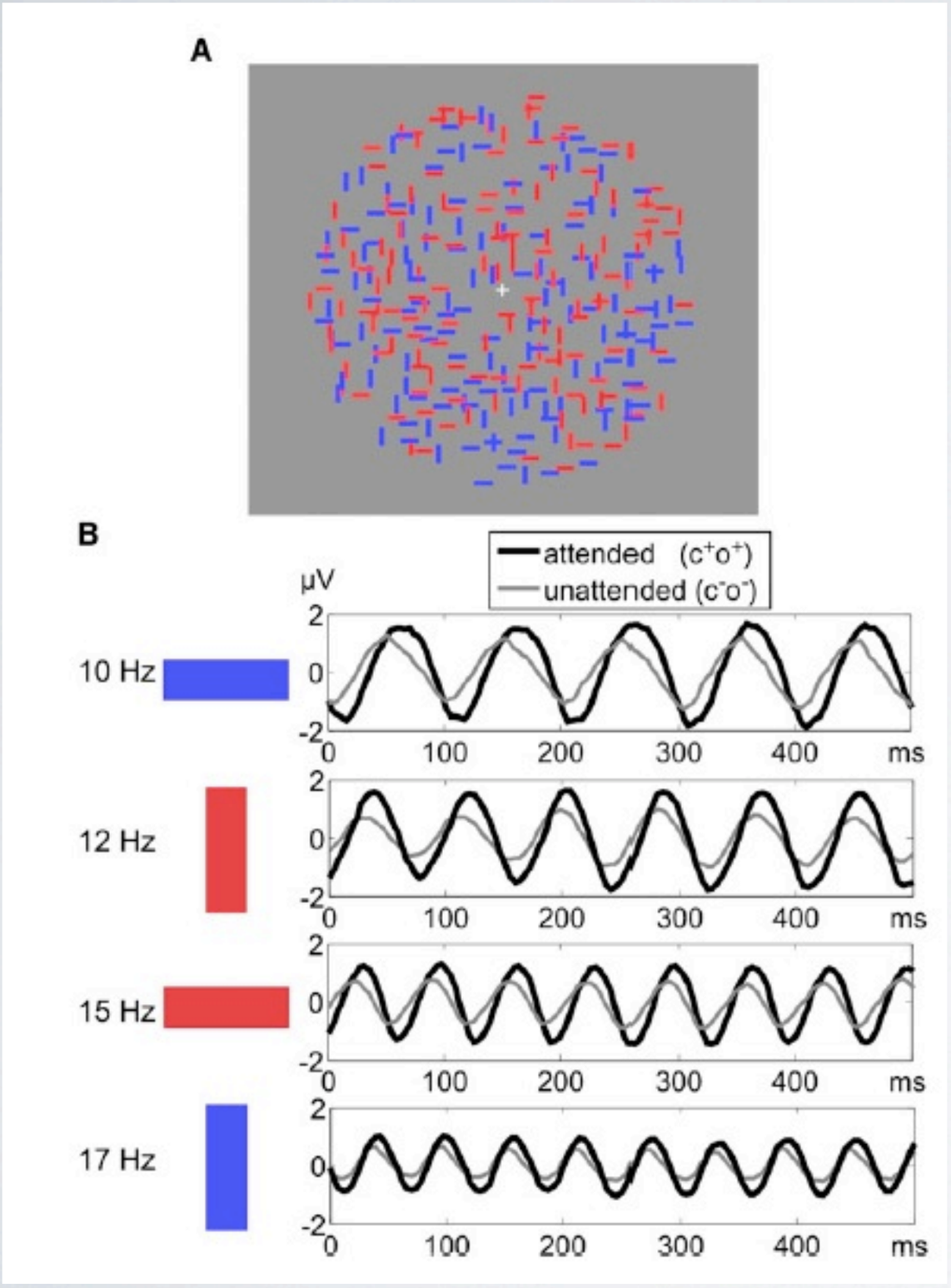


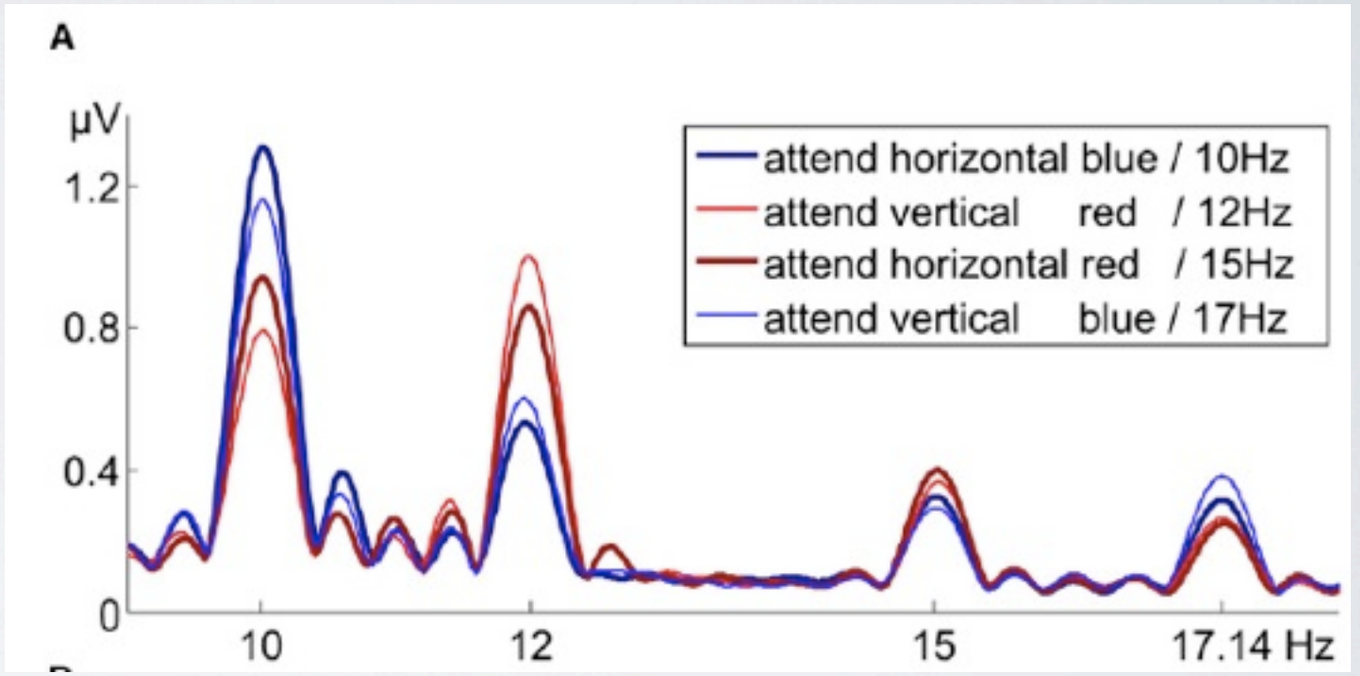
Muller et al. 1998



Muller et al. 1998

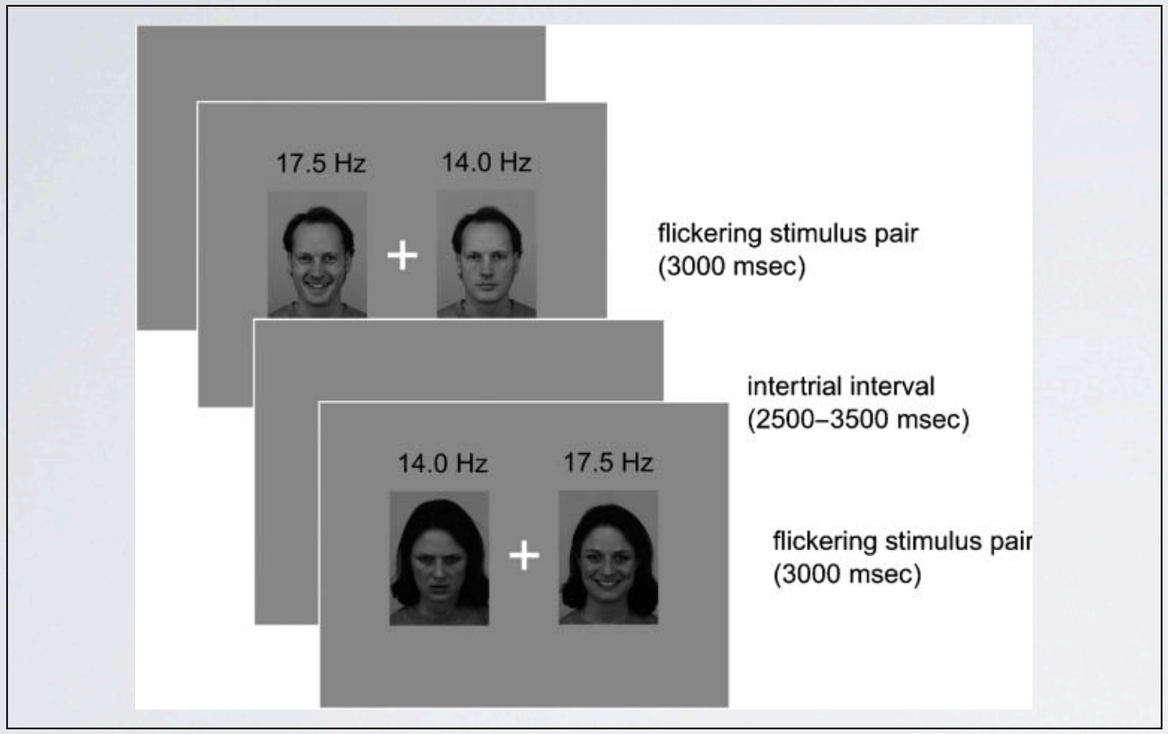
SSVEP FOR FEATURE TAGGING

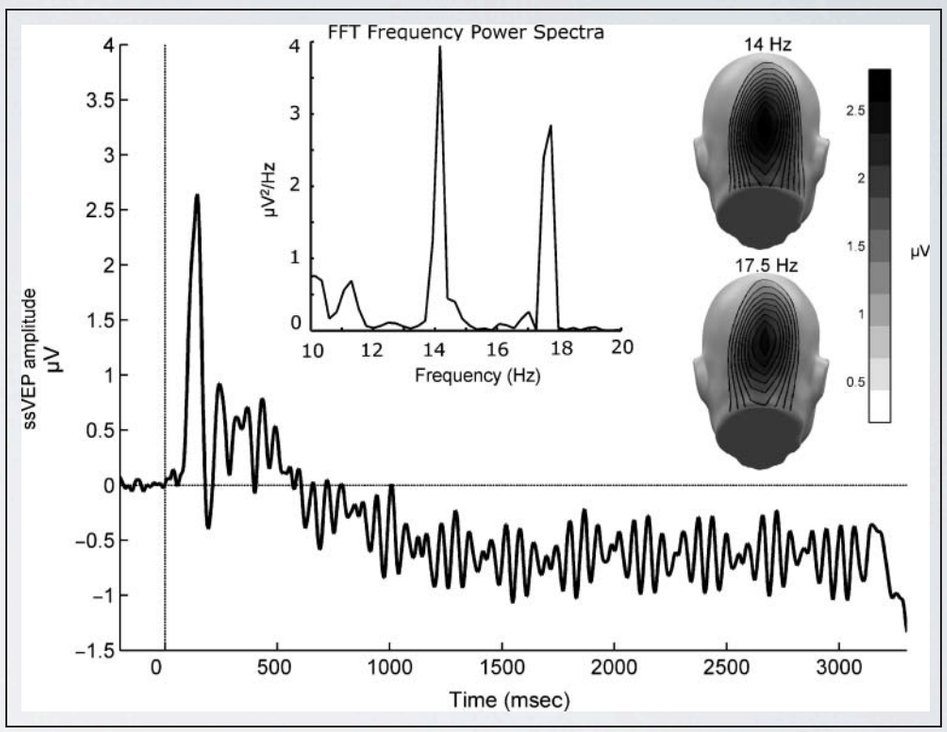


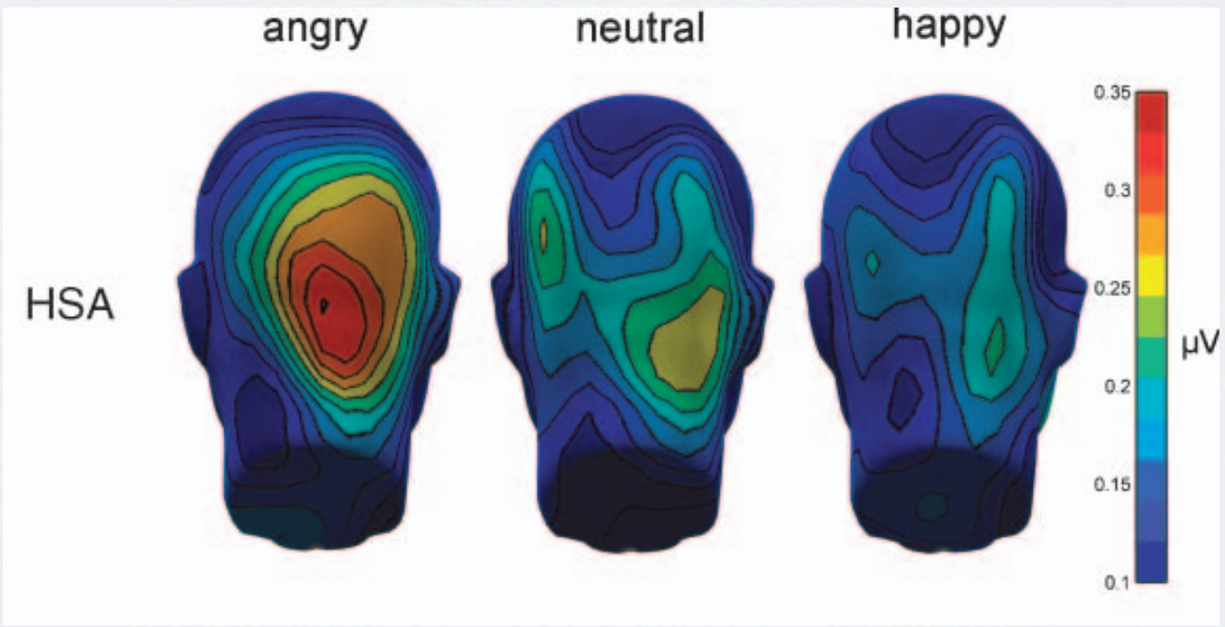


Anderesen et al. 2008

SSVEP COG NEURO EXAMPLE







Wieser et al. 2011

IMPLEMENTATION-STIMULUS

refresh rate
99.6Hz

frame interval
1/99.6 = 0.01s

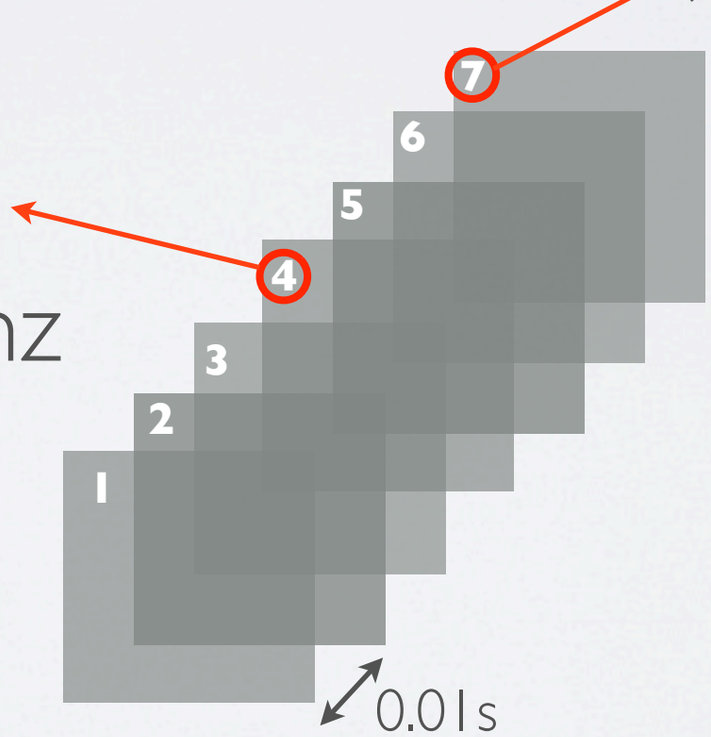
-stimulus frequencies must be chosen as a multiple of the monitor refresh frequency

99.6/4 =24.9Hz

or

1/(0.01..*4)=24.9hz

99.6/7 =14.2Hz



STIMULUS-PSYCHTOOLBOX FUNCTIONS

getting inter-frame interval of monitor

```
ifi = Screen('GetFlipInterval', window);
```

getting inter-stimulus interval

```
f = 14.2;
isi = 1/f;
```

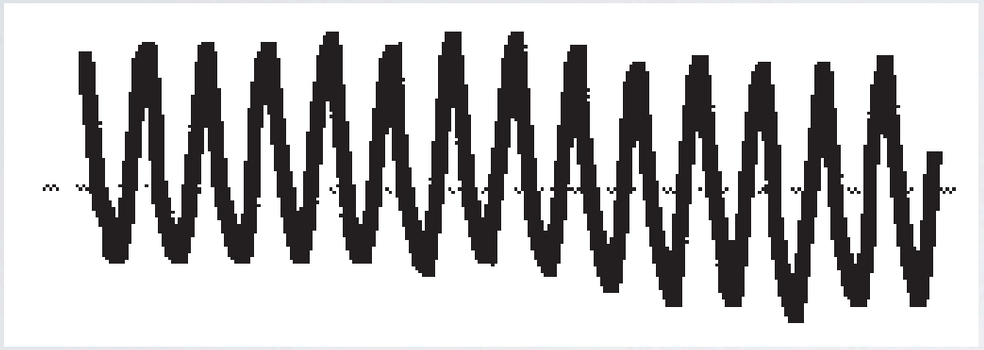
loop to display flicker

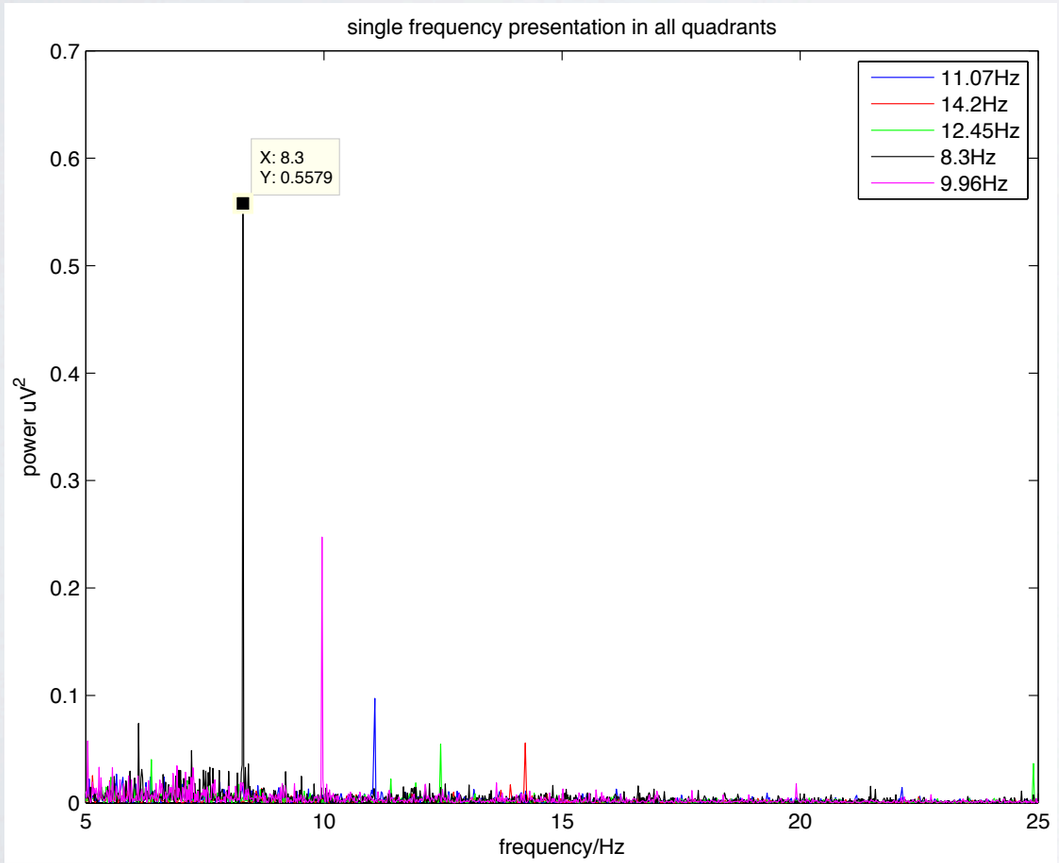
```
displayTime = 3;
start = getSecs();
prevVbl = Screen(‘Flip’,window);

while(now < start + displayTime;)
     if(currentInterval >= isi)
         Screen(‘DrawTextures’,window,texture);
         currentInterval = 0;
      end

      vbl = Screen(‘Flip’,window);
      currentInterval = currentInterval + round((vbl-prevVbl)/ifi);
      prevVbl = vbl;
      now = getSecs();
end
```

ANALYSIS





time domain signal

↓

averaging

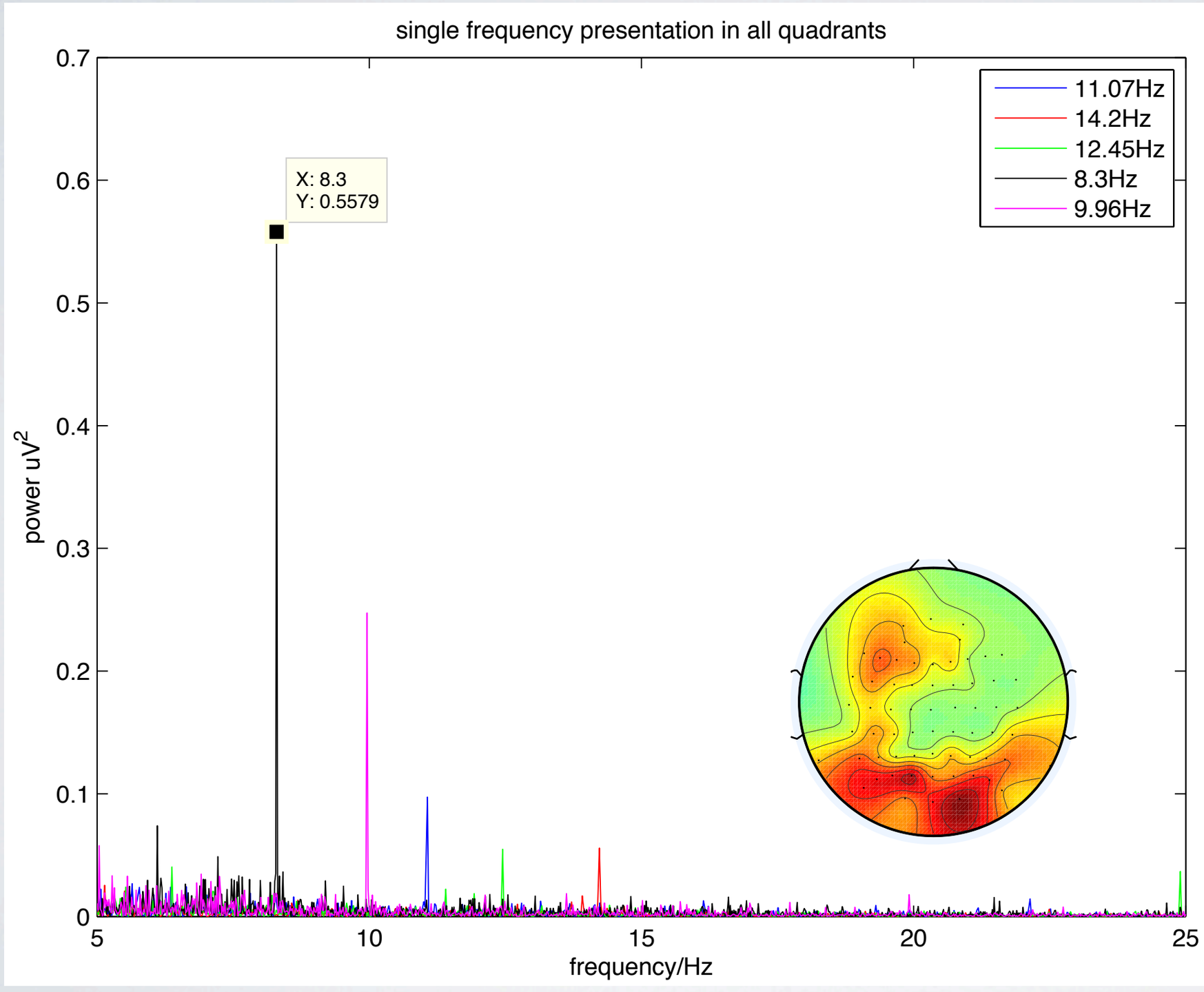
↓

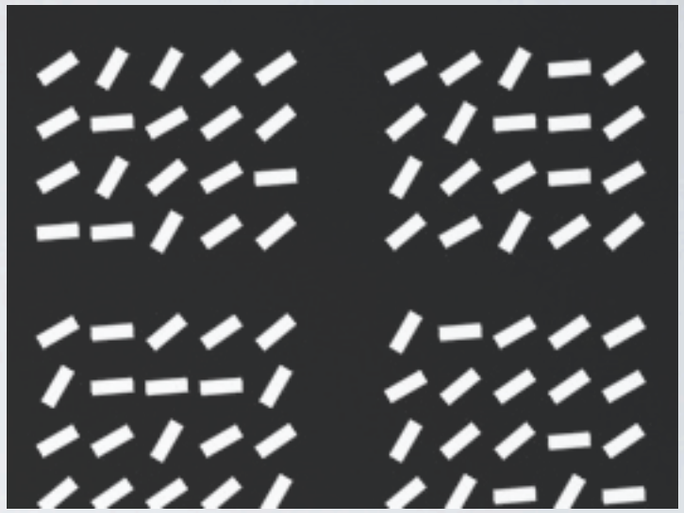
matlab FFT

↓

frequency domain signal

SEPARATE FREQUENCY RESPONSES





CONCLUSIONS

- SSVEP is a powerful technique specially useful for probing attention related aspects

- provides high temporal resolution signals for analysis

- analysis is fairly simple

- reliable and robust response if you get the stimulus and setup right.