Neuroinformatics Quiz-1

(Q1)

For the experiment I would like to specify:

- No. of electrodes = 64
- Sampling Rate = 512Hz
- A good Response device
- Eye Tracker.

Choosing 64 electrodes is generally considered optimal for any kind of analysis, because choosing more electrodes = more time for setup, more preprocessing (applying gel for all electrodes) and expensive. So choosing 64 EEG channels would be cost effective.

According to Nyquist rate, we have to sample at the rate twice the highest frequency component to avoid aliasing and perfect reconstruction(bare minimum). We can always downsample the rate so choosing high won't be a loss (should be atleast 20-40x).

The other two requirements are also useful, a good response device will make the subject easier to handle and increase the accuracy and interest in the experiment instead of figuring out where the button might be.

Eye trackers can also be used for several purposes. It will facilitate the processing and cleaning dataset, It can also be used to measure changes in pupil dilation and there are methods that improve the temporal precision of pupil response.

(Q2)

(1) More trials leads to more accurate results. So it is recommended to plan for at least 20-30 trails per condition.
(2) It is ideally recommended to have the same number of subjects for both conditions to avoid bias. I would recommend having at least 20-30 subjects.
(3) We can epoch the data around the task periods preceding the baseline and we have to include buffer zones before and after task periods for time frequency analysis to avoid any edge artifacts.
(4) At early - raw eeg data, plots after preprocessing, spectral power density plots.
    At mid stages - ERPs, butterfly plots, global field power,time frequency analysis etc..

At late stages - Topographical maps,images,plots of statistical comparisons between 2 conditions. Etc..

(Q3)

- The major sources of artifacts here are Eye blinks - they are easy to identify, they do not destroy the brain generated signal but rather linearly sum on top of brain generated EEG. We can remove them using ICA, regression techniques. One of the problems is that the subject can sometimes miss the stimulus.
- Jaw movements and muscle activity - they can create a high frequency and high amplitude signals which can also be removed by Independent component analysis,
- Electrical noise from device - can be filtered with notch filter (if line noise) but sometimes it might filter the actual neural recording.

(Q4)

Given ,

EEG Dataset – epoched trials of 1 sec baseline + task activity of 2 seconds (stimulus)
Initial : Analyze the alpha activity (8-12) Hz
Later : Need of exploring the deltaband(2-4)Hz

When we apply filter for already epoched data it can cause the artificial oscillations or ripples also called ringing artifacts results from poorly designed filters.These artifacts can disrupt the baseline and task periods especially for lower frequencies (if we use a high pass filter).Hence the robust increase in delta power during the task might be chance.

We have to apply filter for continuous non epoched data to avoid these artifacts and we can also use buffer zones / reflections. In this way we can fix or validate our analysis.

(Q5)

(a) X axis - time (in seconds) 0-4 sec
Y axis - frequency (in Hz) 4-14 Hz

My initial observation is there is a strong band with red color of elevated power around 8-12 Hz and it fades out slowly at Read out period.

(b) From the plot given,
I would support the theory of working memory because power appears relatively stable and consistent across the delay period and the slight change near the read out phase also suggests that WM is updated or released.

Hence I support the WM theory.