Gina Cody School of Engineering and Computer Science

Department of Electrical and Computer Engineering.

ELEC 6671 – Biological Signal Processing.

Winter 2022.

Final Report on Multiple Comparison Correction by Varying The P-Value.

Submitted To:

Dr. Habib Benali

Submitted By:

Pooja Reddy Parvathareddy (40185315)

Venu Babu Podila (40159998)

Vinishaa Reddy Kuntalo (40181334)

Nag Prudhvi Lanka (40164553)

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

The main problem statement is to assess the effects of changing the p-value threshold to the following values: 0.001, 0.05, and 0.1 and carrying out the experiment with and without multiple comparison corrections. Multiple Comparisons Tests (MCTs) are performed on the mean of experimental conditions repeatedly. Using fMRI data, we evaluated some commonly used methods for multiple comparison correction implemented in SPM12. The statistical probability of incorrectly rejecting H_0 will significantly inflate along with the increased number of simultaneously tested hypotheses. The Multiple comparison issues do follow a technique called Bonferroni Correction, but this has a problem since we can make a relatively close estimate about what the signal intensity will look like for a voxel given its neighbors, the voxels are not completely independent. this is likely to result in a high false-negative rate - that is, failing to reject the null hypothesis when there is an effect but fortunately there is an alternative known as cluster correction (most popular fMRI analysis). These correction methods can be performed at different levels of inference using fMRI analysis software (e.g., SPM) and customized MATLAB codes. It is well accepted that an appropriate significance level α, such as 0.05 or 0.01, is pre-specified to guarantee the probability of incorrectly rejecting a single test of the null hypothesis (H_0) no larger than α. However, there are many situations where more than one or even a large number of hypotheses are simultaneously tested, which is referred to as multiple comparisons.

```
config.contrasts(icon).name = 'audio-video';
config.contrasts(icon).convec = [-1 -1 1 -1 1 -1 1 -1 1 -1 0];
icon = icon + 1;
config.contrasts(icon).name = 'video-audio';
config.contrasts(icon).convec = [-1 -1 1 -1 1 -1 1 -1 1 -1 0] * -1;
icon = icon + 1;
icon = icon + 2;
config.contrasts(icon).name = 'left click-right click';
config.contrasts(icon).convec = [-1 -1 1 1 -1 -1 1 -1 1 -1 0];
icon = icon + 1;
```

Fig 1: pipeline code with video-audio & left and right.

The fMRI procedure entails the following stages that must be completed for the findings to be obtained: Smoothing, Spatial Normalization, General Linear Model, Beta Estimation, Contrast Maps, Statistical Inference, Batch Processing, Group Level Analysis. Model specification is one of the major parts in the process. This process is followed by Review, Estimate, and Result using the SPM12 in MATLAB. Review represent the collinearity amongst the four regressors we actually care about. Estimate is used to get a sense for what information these images contain and is followed by result and these are useful to look at the data at individual voxels.

METHODS

To determine neural activity in a single individual, the first level of analysis was to create a design matrix that included eight experimental conditions. To do this, we perform review, estimate, and finally observe the results. All these are found in the fMRI menu which is as below.

Review:

A design matrix can be obtained by 'review' in SPM by the path Review >> origin >> GH158 >> bold >> SPM.mat

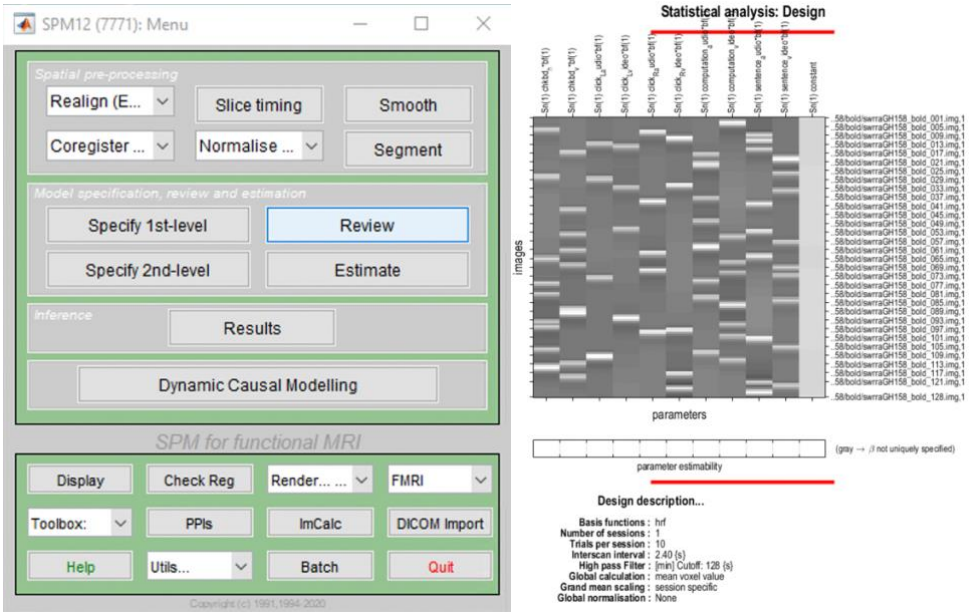

Fig 2: fMRI menu & Design matrix.

Nine columns are in the design matrix, eight relate to experimental conditions and one to bias. Furthermore, the design window provides timing and frequency domain views of all eight experimental conditions.

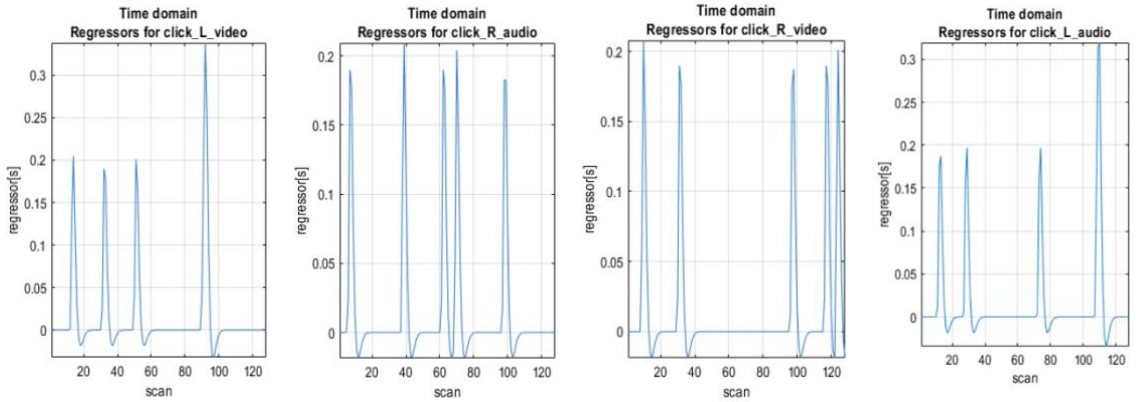

Fig 3: L_video, L_audio, R_video & R_audio.

Estimate:

Now we will perform estimation after review by selecting SPM.mat by path origin\GH158\ bold and then will choose .classical as the method and run the task by saving the batch data.

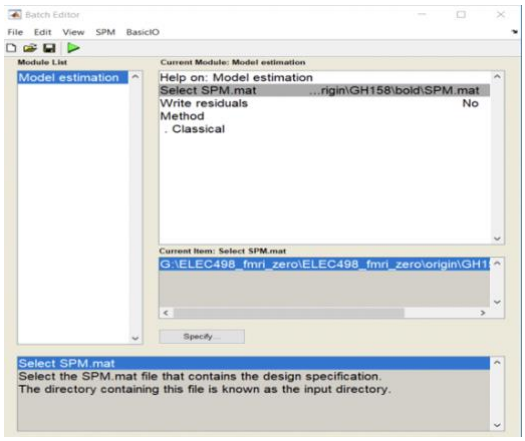

Fig 4: fMRI menu & result tab

Results:

It is necessary to create the SPM.mat file from the Estimate to access the Contrast Manager and view the visualization. When the result is displayed, the brain scans may have multiple blackpatches. The black dots, however, can be used to demonstrate that the defined assumption is valid in around 95 percent of the cases. The darker dots indicate a higher probability in those places. Contrast manager is responsible for the black dots, since it is a statistical way to compute their locations.

We will perform the results by following path Result>>origin>>GH158>>BOLD>> SPM.mat>>done

Select t-contrast >> define new contrast in SPM contrast manager and choose the name of assumption as 'Video-Audio' and the type as t-contrast and set the values as contrast: [-1 -1 1 -1 1 -1 1 -1 1 -1 0]

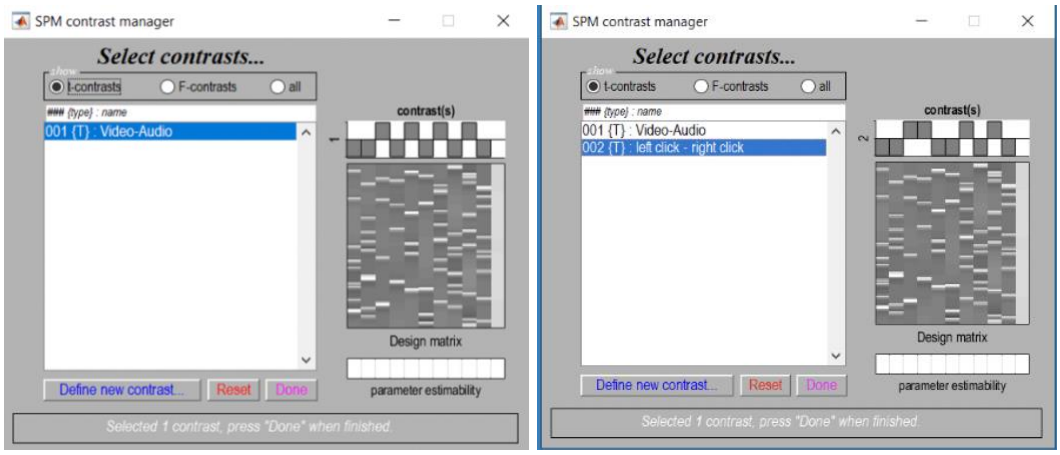

Fig 5: SPM contrast manager with both conditions.

Then set few conditions by selecting apply masking as none and change the values of p, extent threshold and then save the batch file.

RESULTS

With multiple comparison correction:

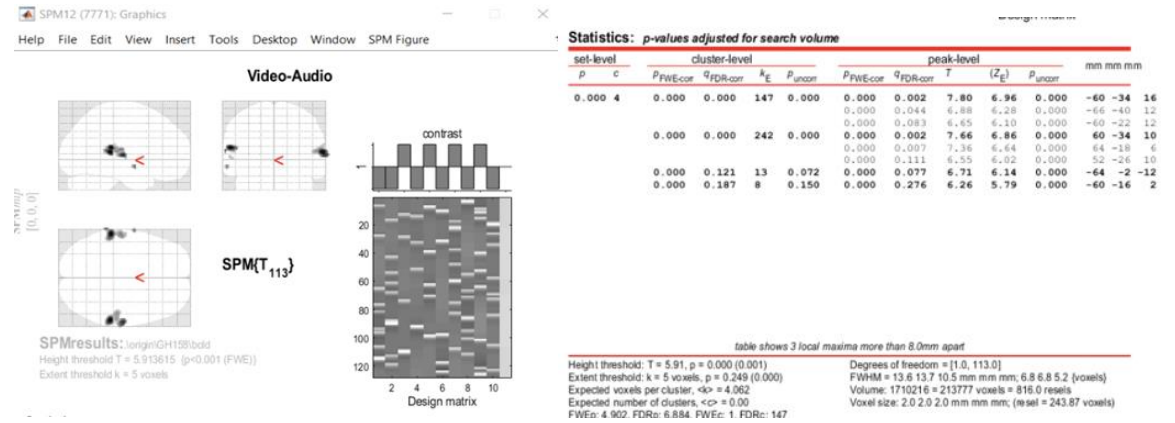

Fig 6: video-audio P value adjustment with FWE=0.001

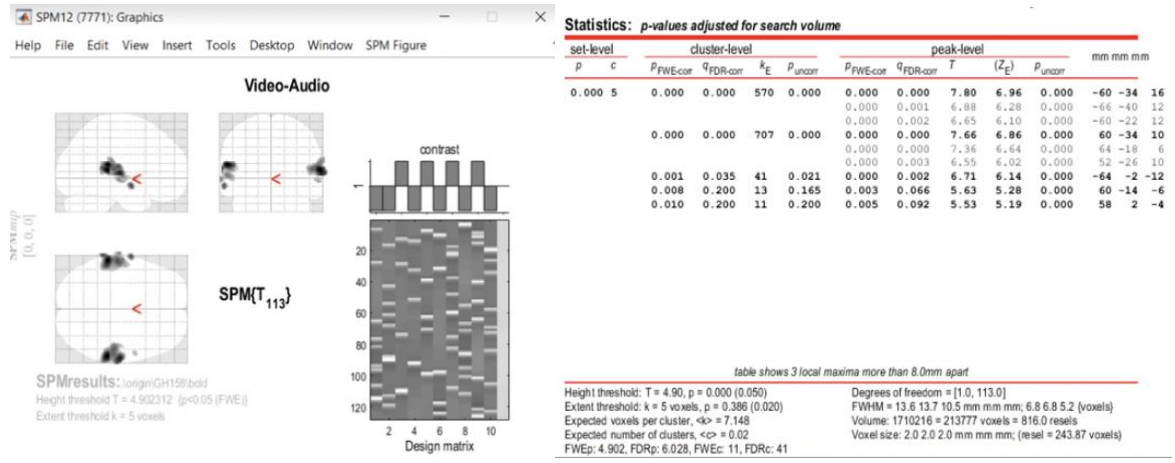

Fig 7: video-audio P value adjustment with FWE=0.05

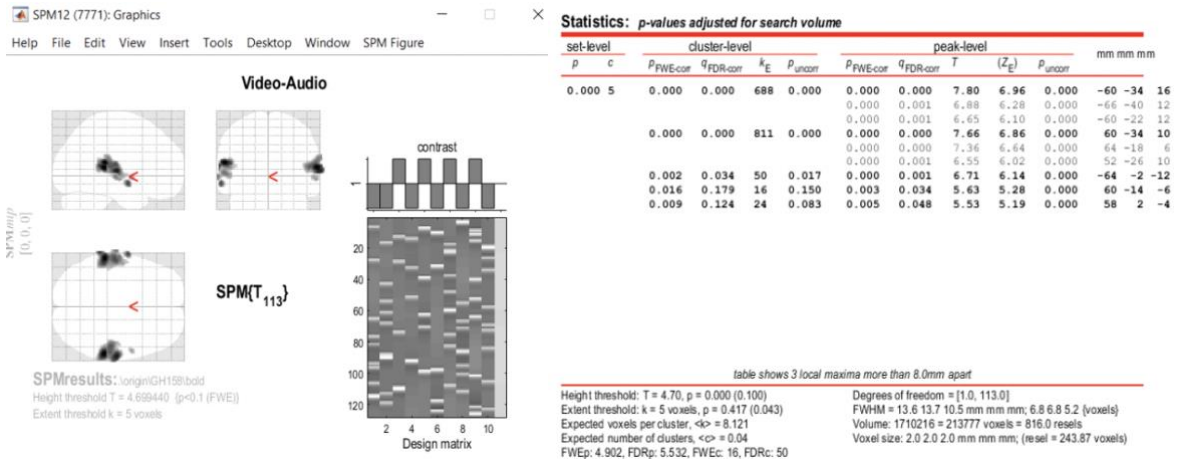

Fig 8: video-audio P value adjustment with FEW= 0.1

Now we'll modify the contrast values as shown below to watch how the graphics change.
The spm12 was given the following values.
Select t-contrast >> define new contrast in SPM contrast manager and choose the name of assumption as ‘left click-right click’ and the type as t-contrast and set the values as contrast: [-1 -1 1 1 -1 -1 1 -1 1 -1 0]. When done, a new assumption will be added as ‘left click-right click’ along with ‘Video-Audio’

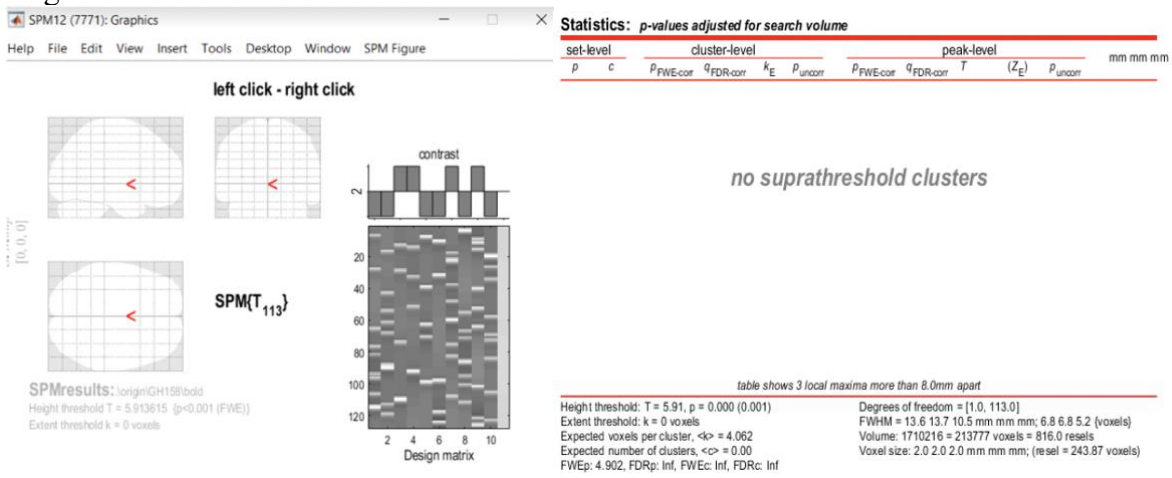

Fig 9: left-click right-click P value adjustment with FEW= 0.001

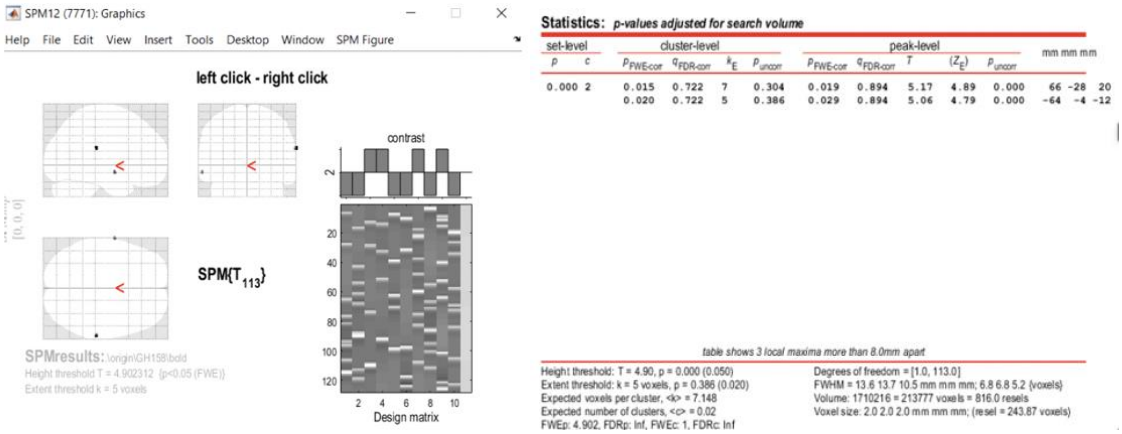

Fig 10: left-click right-click P value adjustment with FEW= 0.05

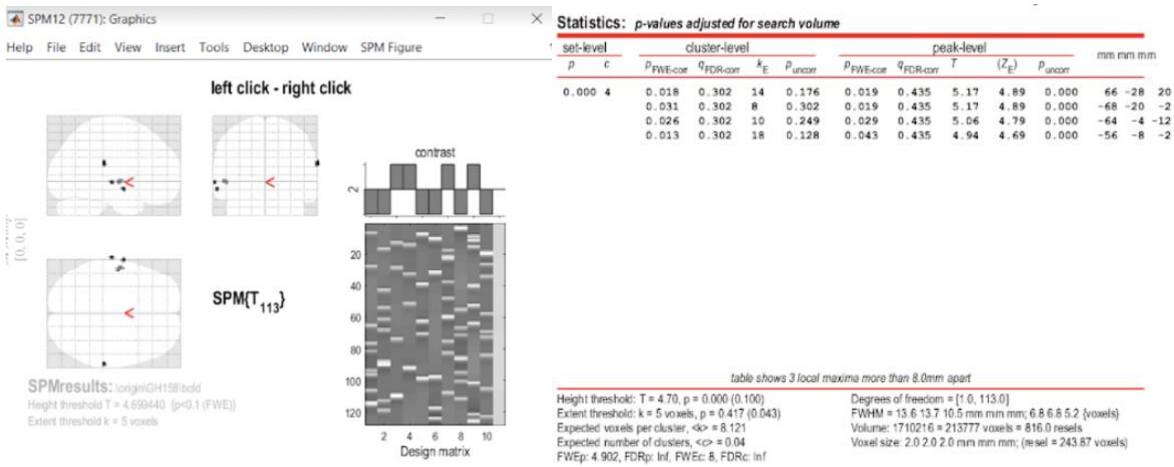

Fig 11: left-click right-click P value adjustment with FEW= 0.1

Without multiple comparison correction:

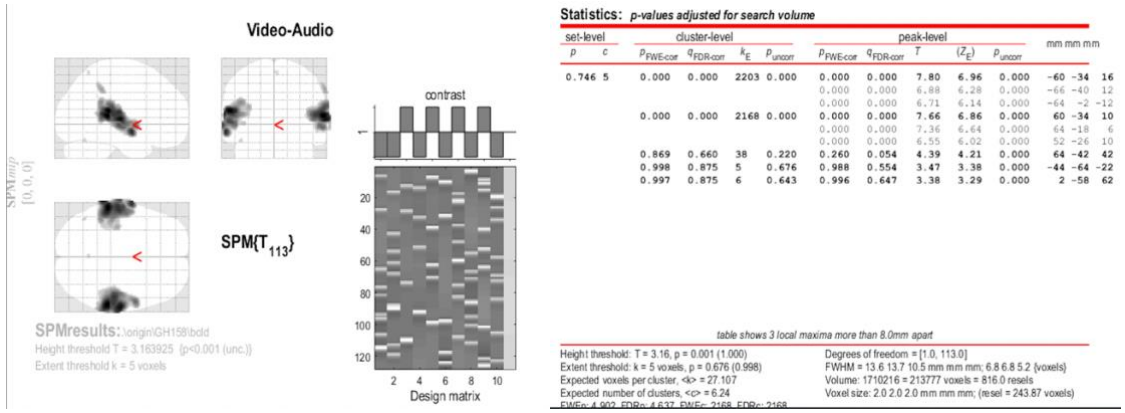

Fig 12: video-audio P value adjustment with FEW= 0.001

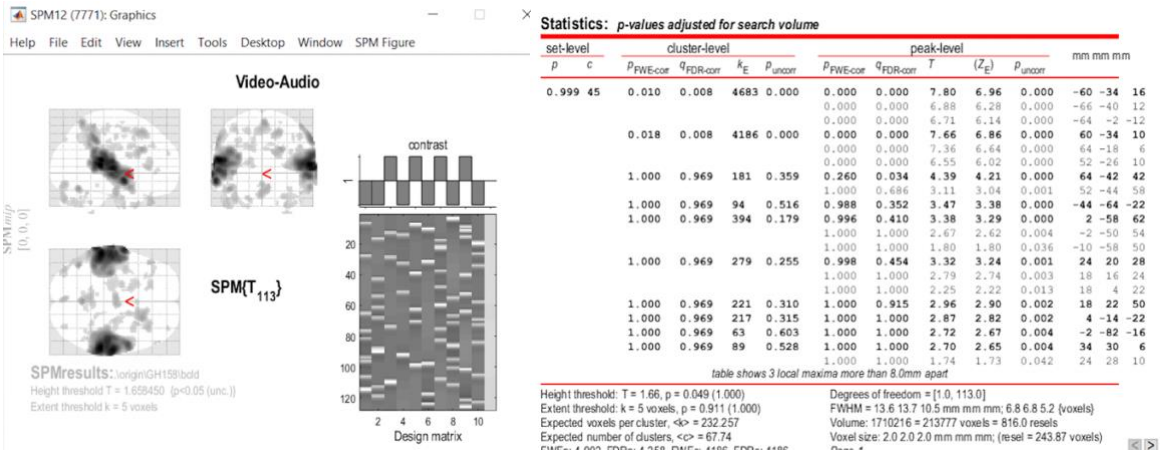

Fig 13: video-audio P value adjustment with FEW= 0.05

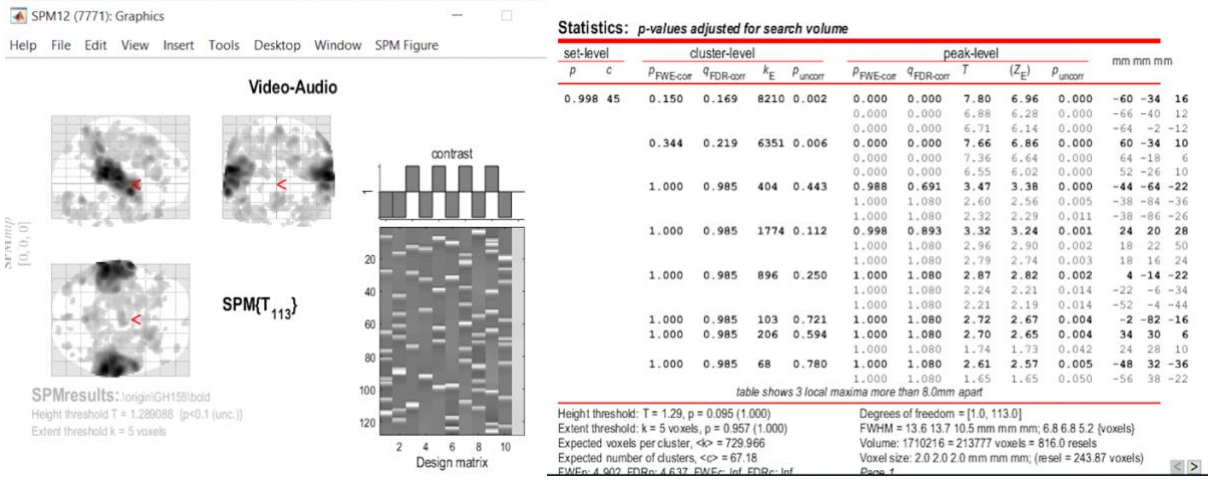

Fig 14: video-audio P value adjustment with FEW= 0.01

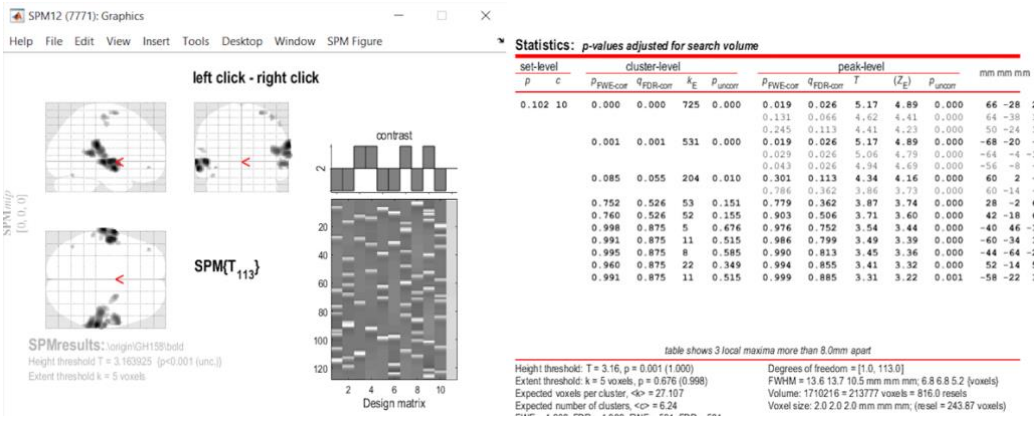

Fig 15: left-click right-click P value adjustment with FEW= 0.001

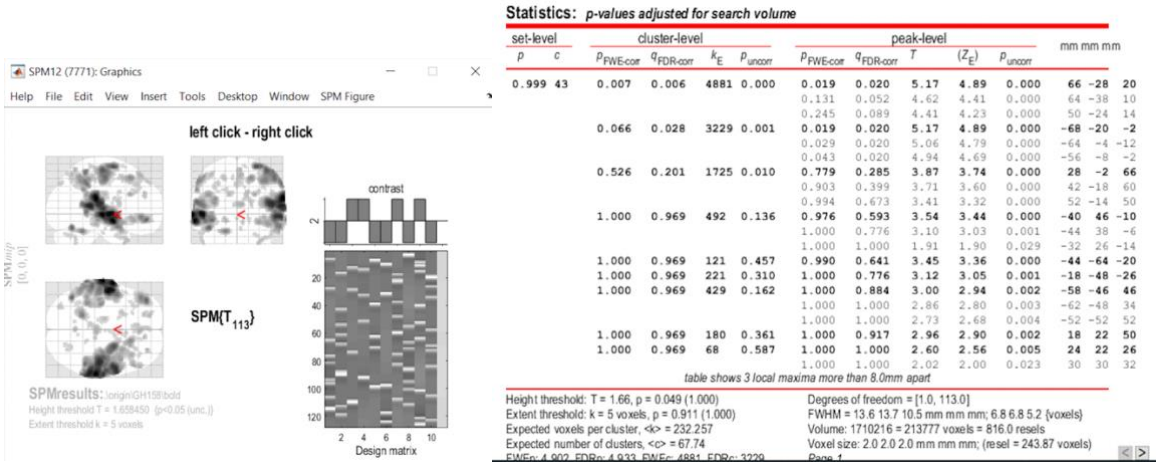

Fig 16: left-click right-click P value adjustment with FEW= 0.05

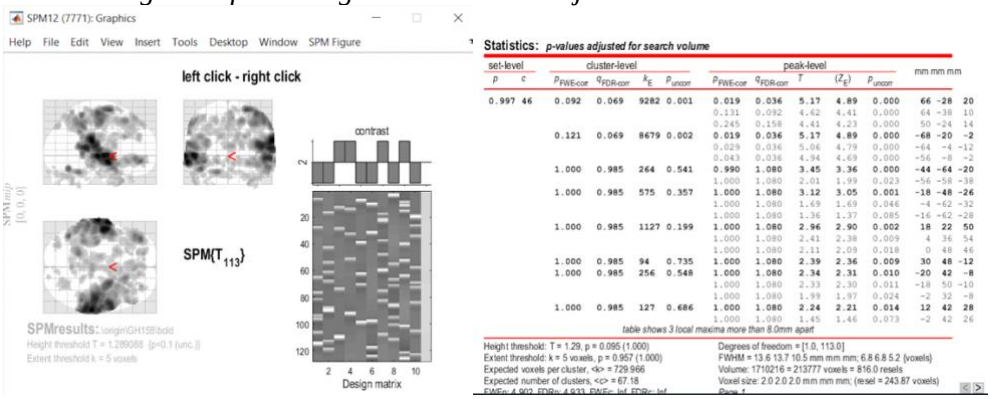

Fig 17: left-click right-click P value adjustment with FEW= 0.01

Conclusion:

We have observed a huge variation of data with and without multiple comparison correction, voxel gets activated if p value is less than 0.05 and if P threshold is small, we will have larger area activated regions because of contrast vectors. If P value is large, then we get contrast vectors with more activated regions. We observed more corrected regions in the brain with multiple comparison correction than without multiple comparison correction. However, fMRI modulates the data and provides the corrected outputs with clear understanding.