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# Supplementary file 1 - The further analysis for "The Functional Regression with Reconstructed Functions from Hybrid Principal Components Analysis: With EEG-fMRI Application"

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**Abstract** It is a supplementary file for "The Functional Regression with Reconstructed Functions from Hybrid Principal Components Analysis: With EEG-fMRI Application". In this supplementary, we analyze four datasets including 17 participants. The Electroencephalography (EEG) curves are response functions and the region of interests (ROI) curves of functional Magnetic Resonance Images (fMRI) for all Broadmann Areas' regions are the functional covariates. There are two oddball tasks:1) Auditory and 2) Visual. Each of them has two stimuli: 1) Standard and 2) Target. Therefore, there are four datasets including 1) Auditory Oddball task, standard stimuli, 2) Auditory Oddball task, target stimuli, 3) Visual Oddball task, standard stimuli, and 4) Visual Oddball task, target stimuli. We divide the 36 electrodes into 7 groups: 1) Whole Brain, 2) Frontal, 3) Central, 4) Parietal, 5) Occipital, 6) Right Temporal, and 7) Left Temporal Regions. The process for each dataset is: 1) It decomposes the EEG into functional, longitudinal, and regional dimensions with hybrid principal components analysis (HPCA), 2) It reconstruct the EEG curves based on the first to KLM HPCAs and it fits the signal-compression function-on-function regression with multiple ROI curves (train/test), 3) the correlation and mean squared prediction error (MSPE) between reconstructed EEG and predicted values are calculated and finally, the results are procudes in the graphs. The best number of HPCA based on the MSPE, correlation and elapsed times group by region of brain are chosen.

**Keywords** Functional Data Analysis, Hybrid Principal Component, Multiple Functional Covariates, Functional Regression, EEG, fMRI

**AMS 2010 subject classifications** 62M10 , 62F15

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## Contents

**1 Introduction** **2**

**2 The Auditory Odd Ball Task** **3**
2.1 Standard Stimuli . . . 3
2.1.1 The HPCA Decomposition . . . 3
2.1.2 The Reconstructed of the Response . . . 9
2.1.3 The function-on-function result . . . 16
2.1.4 Conclusion . . . 40
2.2 Target Stimuli . . . 41
2.2.1 The HPCA Decomposition . . . 41
2.2.2 The Reconstructed of the Response . . . 47
2.2.3 The function-on-function result . . . 54
2.2.4 Conclusion . . . 85

**3 The Visual Odd Ball Task** **86**
3.1 Standard Stimuli . . . 86
3.1.1 The HPCA Decomposition . . . 86
3.1.2 The Reconstructed of the Response . . . 92
3.1.3 The function-on-function result . . . 99
3.1.4 Conclusion . . . 123
3.2 Target Stimuli . . . 124
3.2.1 The HPCA Decomposition . . . 124
3.2.2 The Reconstructed of the Response . . . 130
3.2.3 The function-on-function result . . . 137
3.2.4 Conclusion . . . 161

**4 Bayesian Simulation** **162**
4.1 Without HPCA . . . 163
4.2 First HPCA . . . 165
4.3 All HPCA . . . 167

## 1. Introduction

There are four datasets in this analysis for 17 participant with Electroencephalography (EEG) curves as response functions and the region of interests (ROI) curves of functional Magnetic Resonance Images (fMRI) as functional covariates ([1]):

1. Auditory Oddball task, standard stimuli
2. Auditory Oddball task, target stimuli
3. Visual Oddball task, standard stimuli
4. Visual Oddball task, target stimuli

In each dataset, following analysis were done:

1. The Hybrid Principal Component Analysis (HPCA) of EEG curves (response function)
2. Reconstructing the EEG curves from HPCA = 1 to HPCA=KLM, separately for different region of the brains:
   - Whole brain (considering all 36 electrodes)
   - Frontal Region (Fp1 – Fp2 – AF3 – AF4- Fz)
   - Central Region (FC1 – FC2 – C3 – Cz – C4)
   - Parietal Region (CP1 – CP2 – P3 – Pz – P4)
   - Occipital Region (PO3 – PO4 – PO7 – PO8 – O1 – Oz – O2)
   - Right Temporal Region (F4 – F8 – FC6 – T8 – RM – CP6 – P8)
   - Left Temporal Region (F3 – F7 – FC5 – T7 – LM – CP5 – P7)
3. The signal compression function-on-function regression with reconstructed EEG as response function and ROIs of fMRI as functional covariates were done for each number of HPCA and each region of the brain. The results are shown in the:
   - Train/test with 10 iterations and two indices:
     - Mean Squared Prediction Error (MSPE).
     - Correlation.
   - Running Time with 10 iterations:
     - User
     - System
     - Elapsed
   - The model fit indices in 10 iterations
4. Finally, the concluding figures were produced:
   - The MSPE over number of HPCA group by train/test by regions.
   - The correlation over number of HPCA group by train/test by regions.
   - The elapsed time over number of HPCA group by train/test by regions.

## 2. The Auditory Odd Ball Task

### *2.1. Standard Stimuli*

*2.1.1. The HPCA Decomposition*

#### 2.1.1.1 The Functional dimension

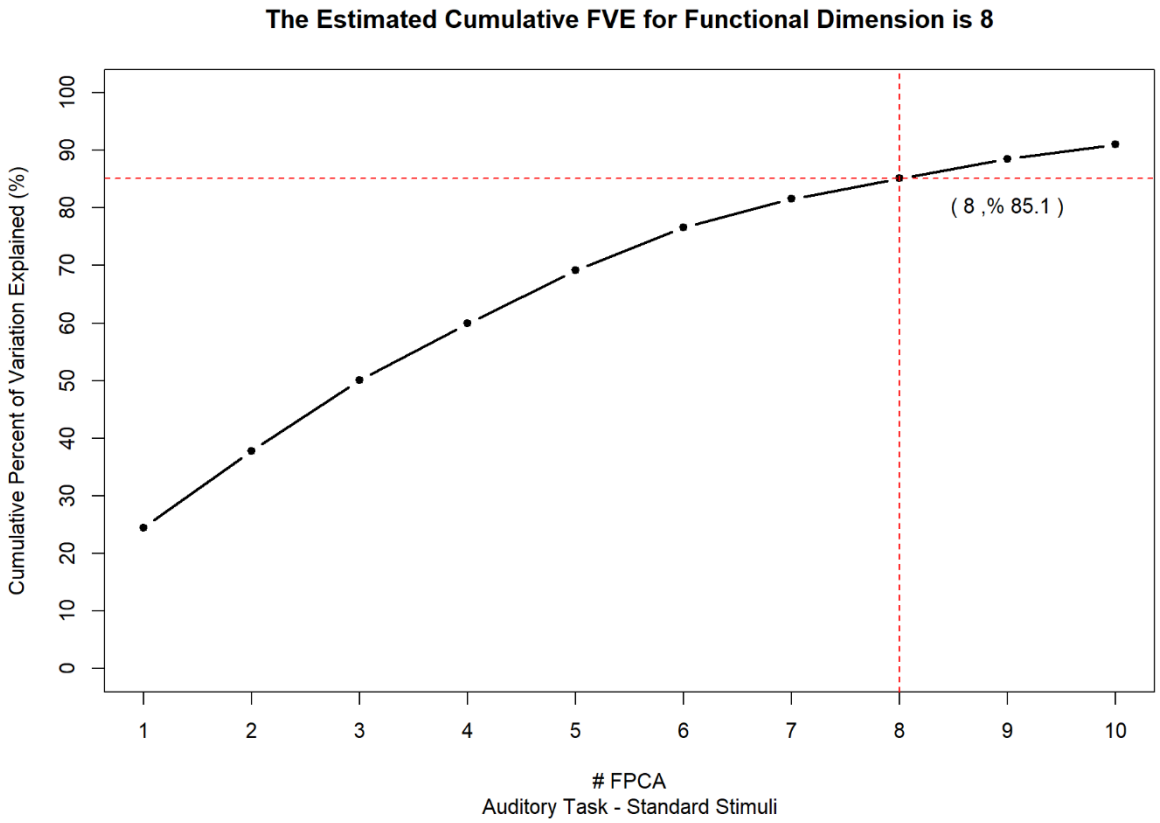



Figure 1. The estimated cumulative fraction of variations (FVE) for functional dimension.

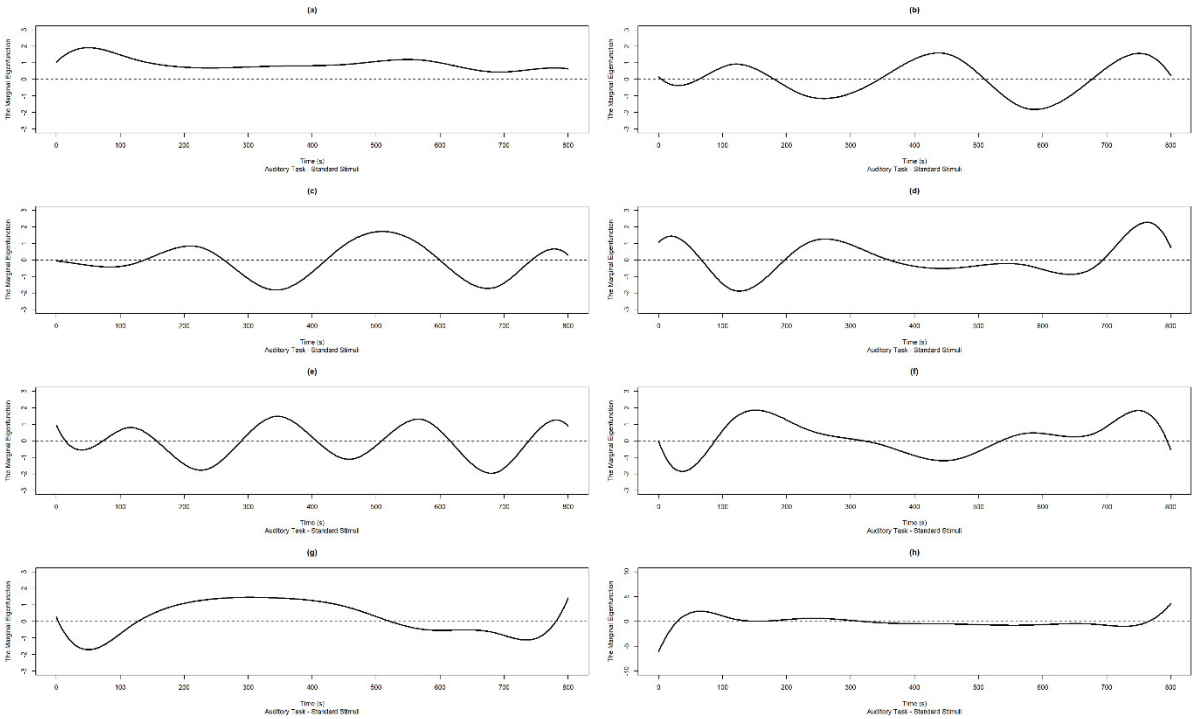



Figure 2. (a, h) Estimated first to eight leading functional marginal eigenfunctions.

According to the Figure 1, the first eight marginal functional principal component analysis (FPCA) capture at least 85% of variation in this dimension. The Figure 2 plots estimated first to eight leading functional marginal eigenfunctions on the x-axis (time).

#### 2.1.1.2 The Longitudinal dimension

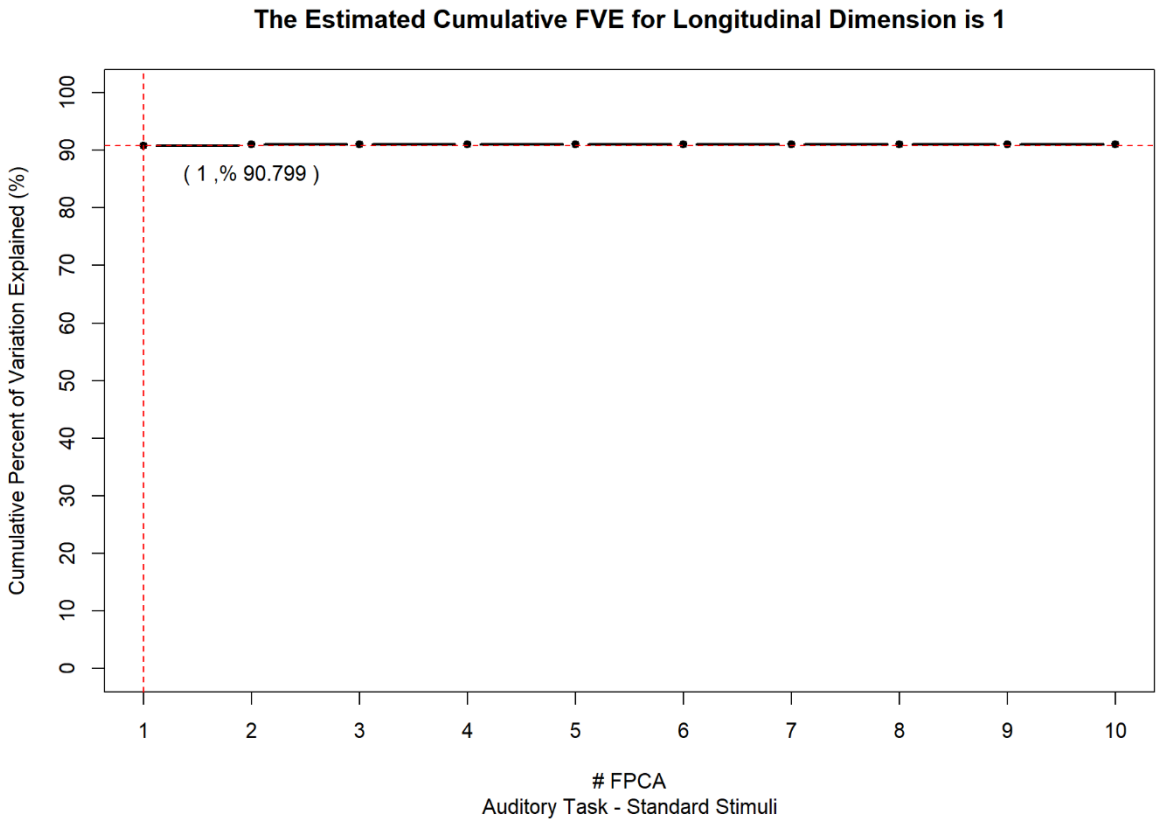



Figure 3. The estimated cumulative fraction of variations (FVE) for longitudinal dimension.

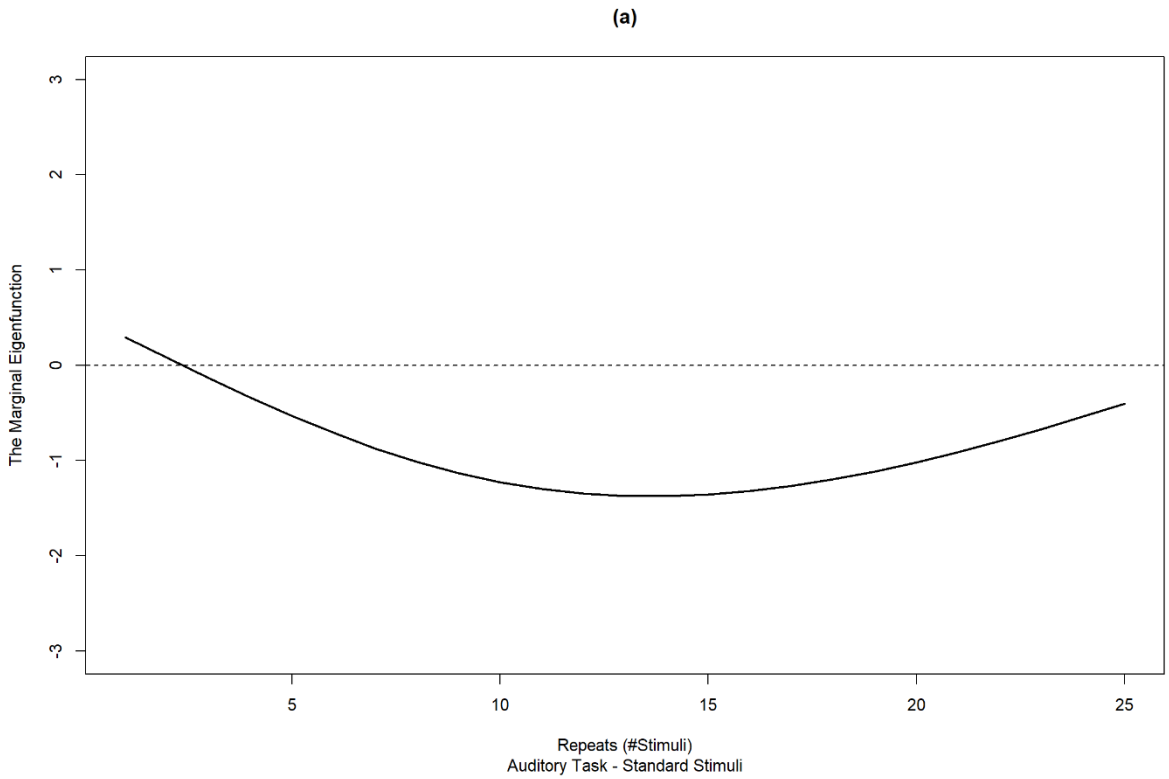



Figure 4. Estimated first leading longitudinal marginal eigenfunctions.

According to the Figure 3, the first marginal functional principal component analysis (FPCA) capture at least 90% of variation in this dimension. The Figure 4 plots estimated first leading longitudinal marginal eigenfunctions.

#### 2.1.1.3 The Regional dimension

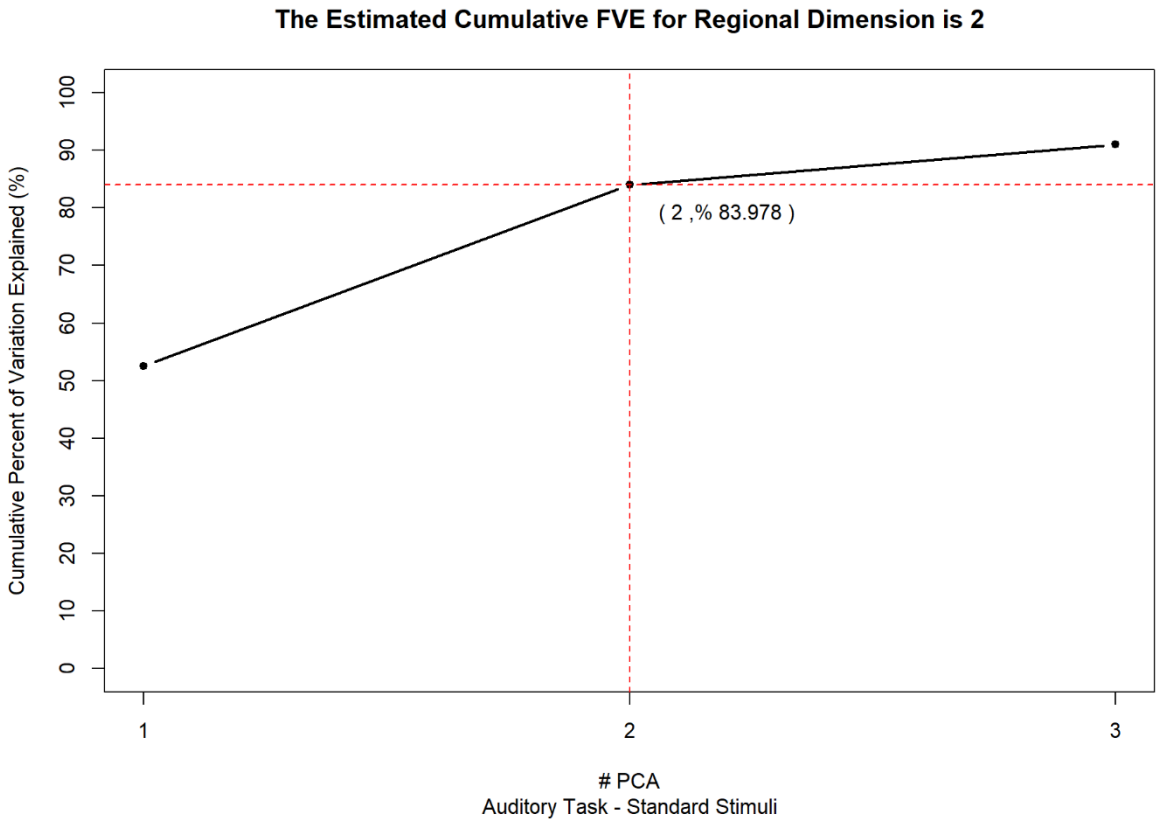



Figure 5. The estimated cumulative fraction of variations (FVE) for regional dimension.

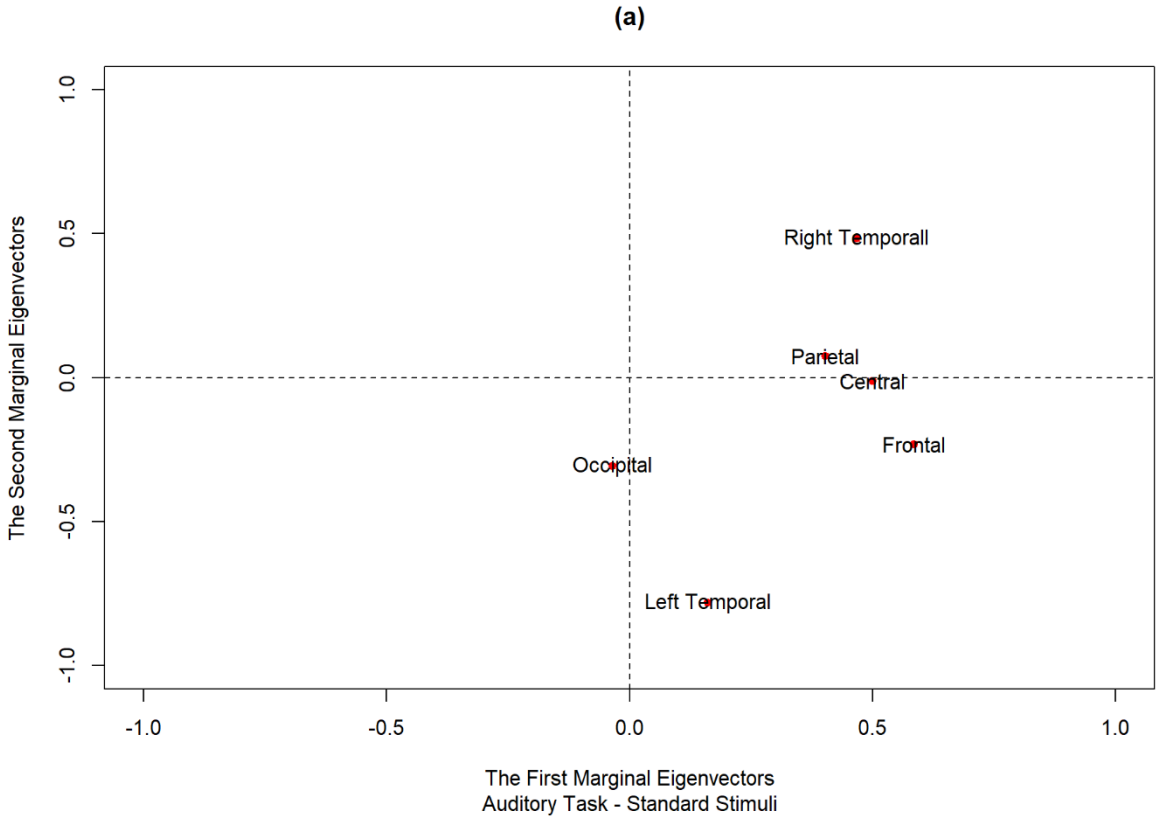



Figure 6. Estimated first and second leading regional marginal eigenvectors.

According to the Figure 5, the first and second marginal principal component analysis (PCA) capture at least nearly 85% of variation in this dimension. The Figure 6 plots estimated first and second leading regional marginal eigenvectors.

*2.1.2. The Reconstructed of the Response .*
The fof regression were conducted group by the number of HPCA and the regions. In the following part, we show the reconstructed ERPs for each subject (in gray) based on the number of HPCA. In this trial, we have 16 HPCA. We also show the point-wise mean and mean ± standard deviation. ( Whole Brain: Figure 7, Frontal region (1): Figure 8, Central Region (2): Figure 9, Occipital Region (3): Figure 10, Parietal Region (4): Figure 11, Left Temporal (5): Figure 12, Right Temporal (6): Figure 13 ).

#### 2.1.2.1 Whole Brain

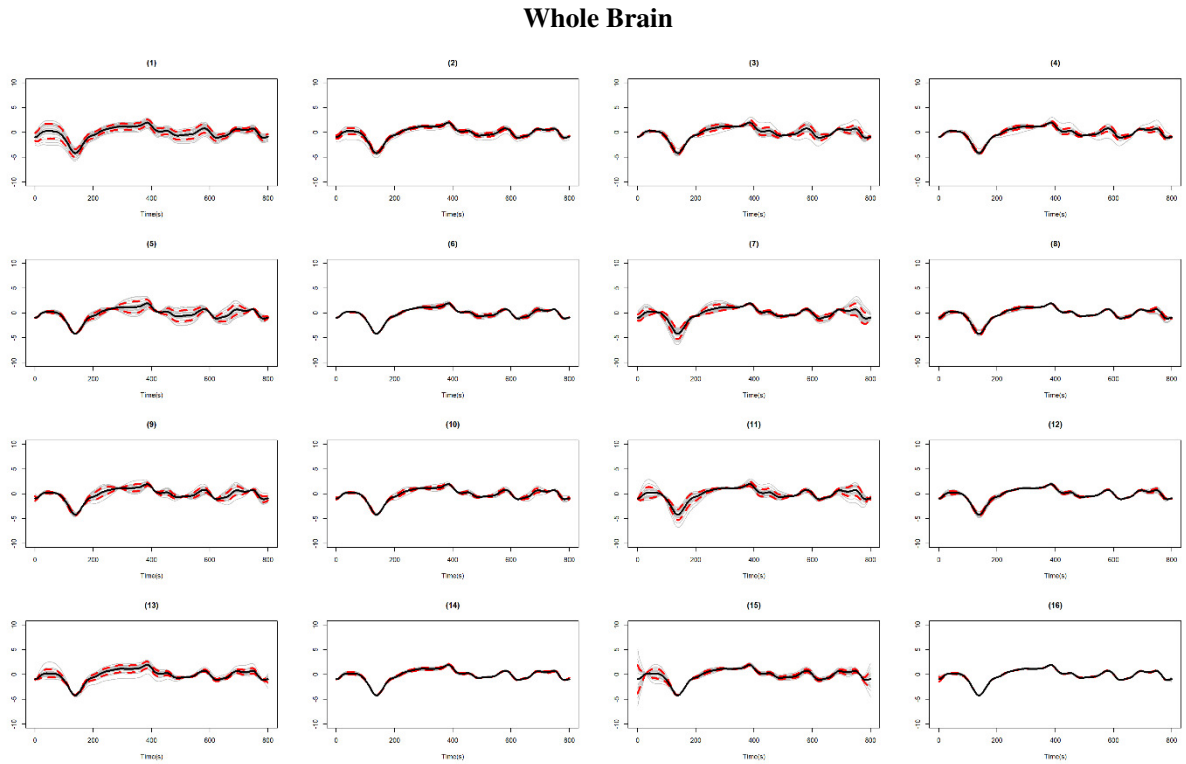



Figure 7. (1-16) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for whole Brain.

#### 2.1.2.2 Frontal Region (1)

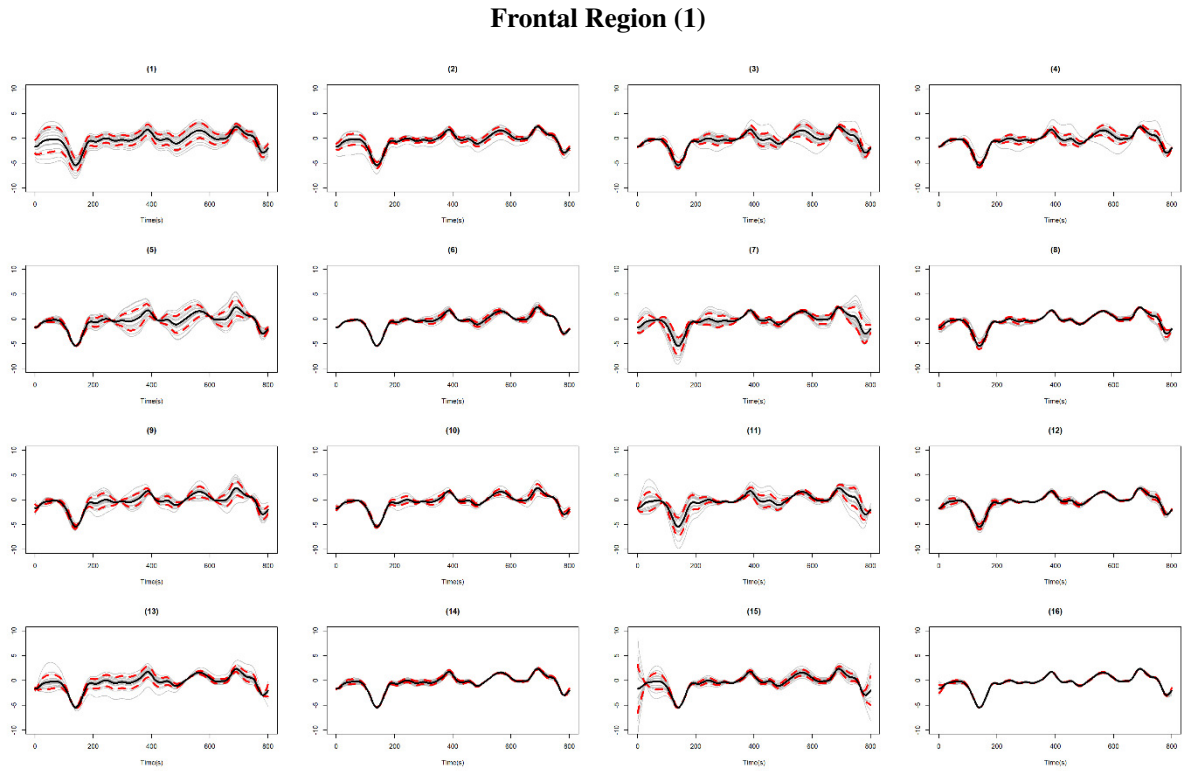



Figure 8. (1-16) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for frontal region of the Brain.

#### 2.1.2.3 Central Region (2)

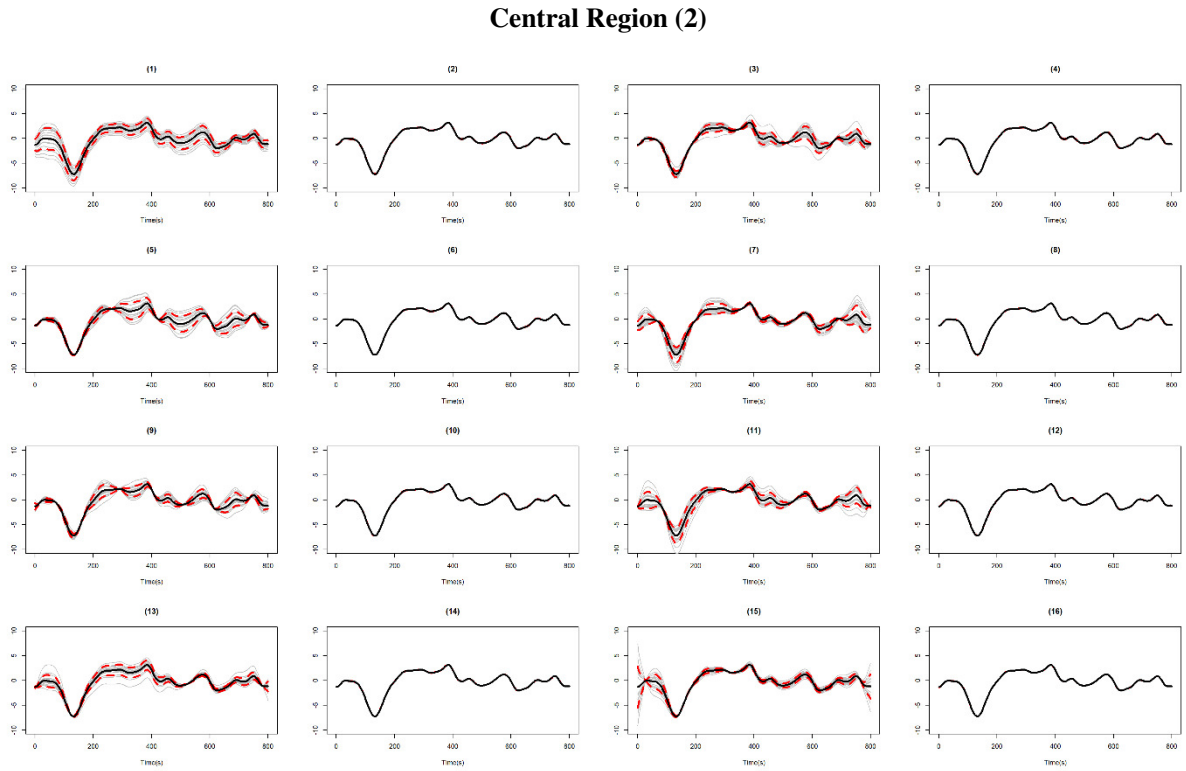



Figure 9. (1-16) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for central region of the Brain.

#### 2.1.2.4 Occipital Region (3)

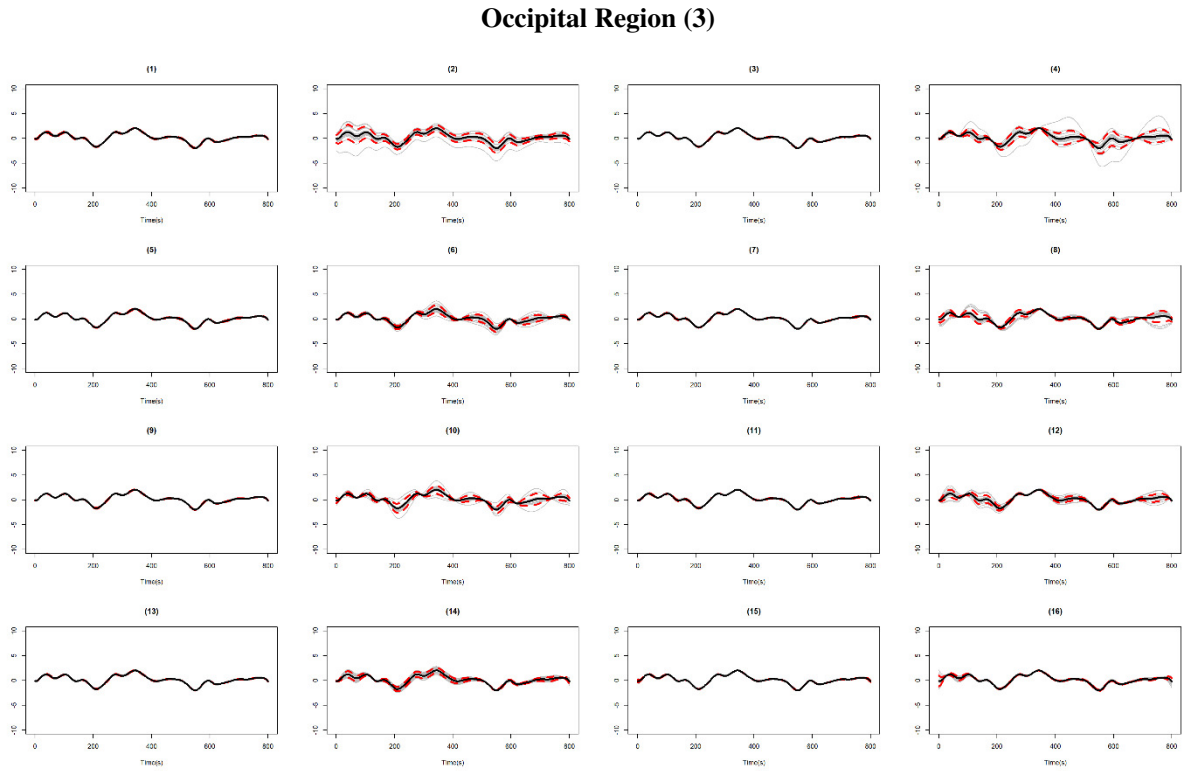



Figure 10. (1-16) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for occipital region of the Brain.

#### 2.1.2.5 Parietal Region (4)

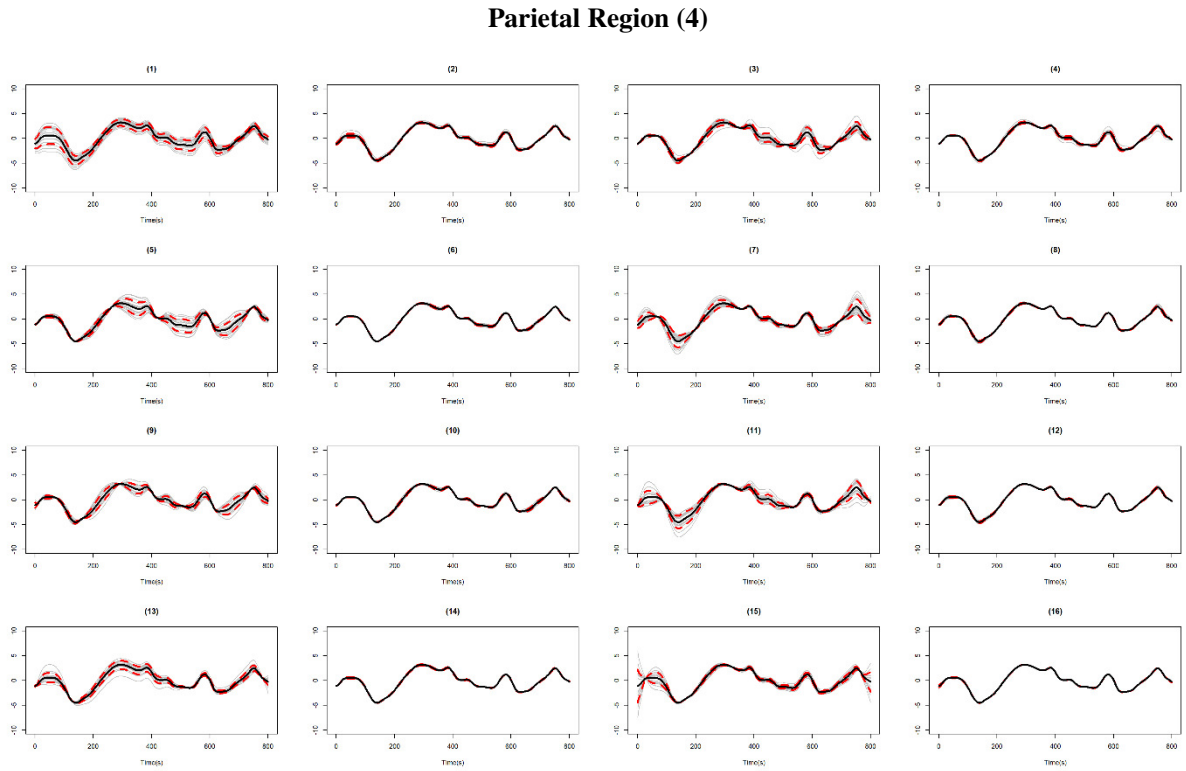



Figure 11. (1-16) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for parietal region of the Brain.

#### 2.1.2.6 Left Temporal (5)

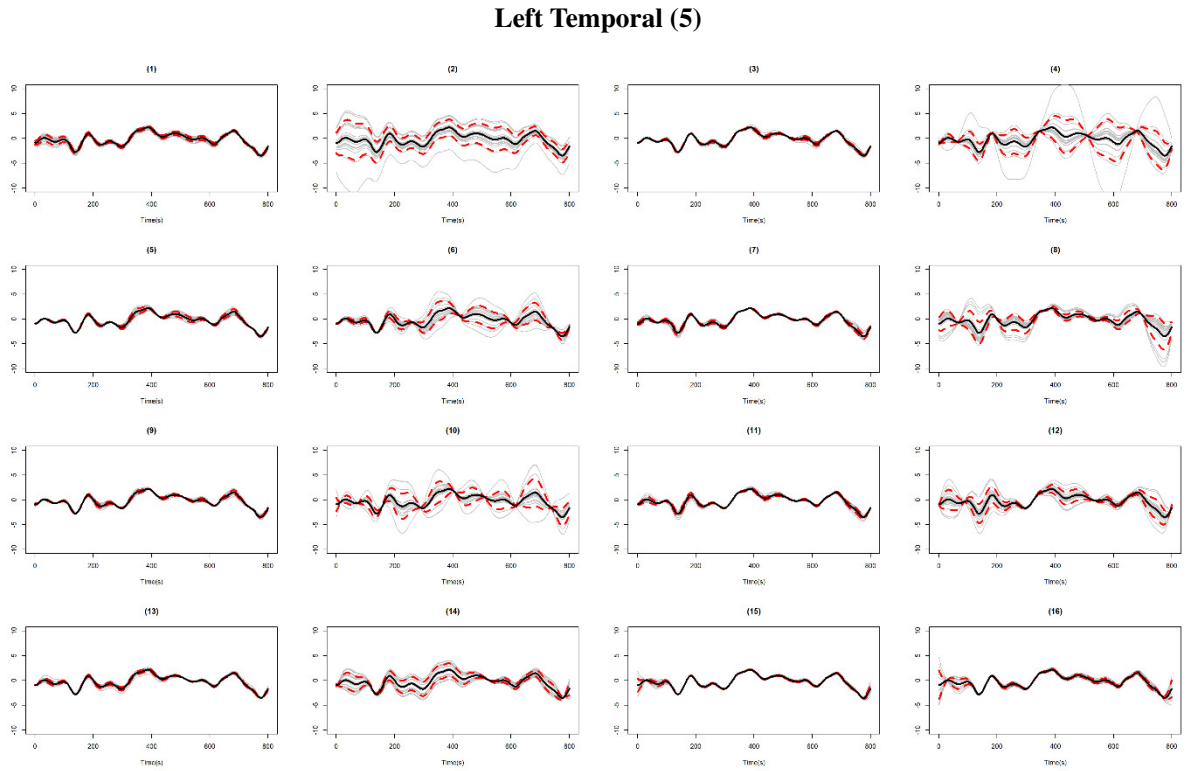



Figure 12. (1-16) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for left temporal region of the Brain.

#### 2.1.2.7 Right Temporal (6)

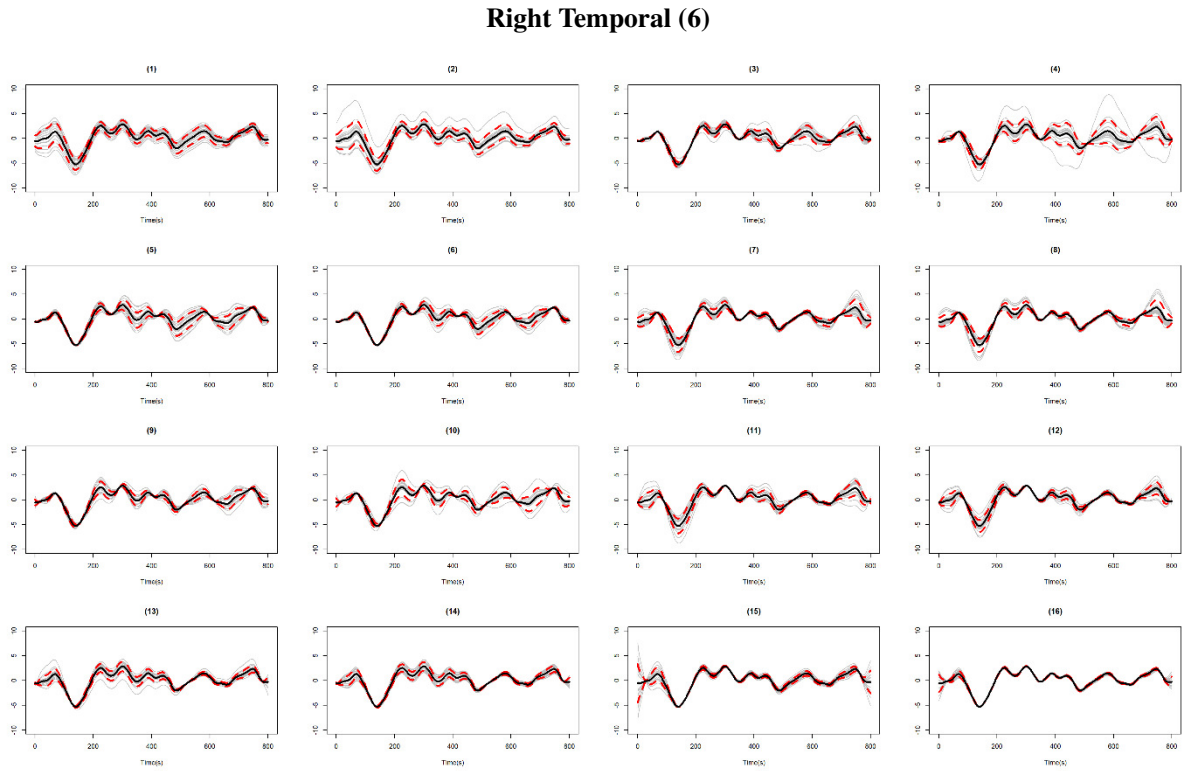



Figure 13. (1-16) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for right temporal region of the Brain.

*2.1.3. The function-on-function result* .
The fof regression result group by the region of the brain and the number of hybrid principal component analysis (HPCA) were reported.

#### 2.1.3.1 Whole Brain

The MSPE and Correlation group by number of HPCA, Train and Test (Table 1)

The User, System and Elapsed Time group by number of HPCA (Table 2): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 3): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| 1 | 0(0,0.002) | 0.071(0.071,0.08) | 1(0.999,1) | 0.964(0.96,0.964) |
| 2 | 0(0,0.003) | 0.033(0.033,0.044) | 1(0.999,1) | 0.983(0.978,0.983) |
| 3 | 0.094(0.013,0.094) | 0.249(0.242,0.249) | 0.952(0.952,0.994) | 0.87(0.87,0.873) |
| 4 | 0.108(0.108,0.108) | 0.218(0.218,0.218) | 0.944(0.944,0.944) | 0.884(0.884,0.884) |
| 5 | 0.12(0.12,0.12) | 0.563(0.563,0.563) | 0.938(0.938,0.938) | 0.692(0.692,0.692) |
| 6 | 0.121(0.121,0.121) | 0.746(0.746,0.746) | 0.937(0.937,0.937) | 0.591(0.591,0.591) |
| 7 | 0.192(0.192,0.192) | 0.737(0.719,0.737) | 0.899(0.899,0.899) | 0.578(0.578,0.586) |
| 8 | 0.176(0.176,0.176) | 0.76(0.76,0.76) | 0.908(0.907,0.908) | 0.566(0.566,0.566) |
| 9 | 0.221(0.214,0.236) | 0.776(0.677,0.778) | 0.882(0.874,0.886) | 0.559(0.558,0.622) |
| 10 | 0.254(0.227,0.265) | 0.666(0.646,0.709) | 0.864(0.857,0.879) | 0.637(0.597,0.644) |
| 11 | 0.319(0.316,0.327) | 0.751(0.732,0.751) | 0.825(0.82,0.827) | 0.568(0.568,0.58) |
| 12 | 0.288(0.258,0.318) | 0.739(0.726,0.744) | 0.844(0.826,0.861) | 0.579(0.575,0.592) |
| 13 | 0.29(0.284,0.333) | 0.842(0.779,0.866) | 0.842(0.816,0.846) | 0.513(0.493,0.543) |
| 14 | 0.347(0.341,0.352) | 0.877(0.877,0.884) | 0.808(0.804,0.811) | 0.487(0.487,0.488) |
| 15 | 0.364(0.339,0.405) | 0.918(0.879,0.95) | 0.797(0.771,0.813) | 0.451(0.448,0.453) |
| 16 | 0.341(0.219,0.352) | 1.037(0.938,1.054) | 0.812(0.805,0.884) | 0.424(0.358,0.436) |

Table 1. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| 1 | 72.645(71.585,73.463) | 0.115(0.05,0.222) | 72.805(72.295,73.778) |
| 2 | 69.75(67.78,70.74) | 0.045(0.023,0.06) | 69.77(67.833,70.76) |
| 3 | 136.82(136.033,139.845) | 0.06(0.03,0.11) | 136.87(136.243,139.985) |
| 4 | 144.04(142.655,145.29) | 0.11(0.087,0.125) | 144.16(142.733,145.543) |
| 5 | 184.945(182.778,185.485) | 0.085(0.063,0.128) | 185.02(182.86,186.23) |
| 6 | 182.69(180.285,186.288) | 0.085(0.073,0.097) | 182.82(180.44,186.363) |
| 7 | 223.605(220.992,226.475) | 0.11(0.11,0.133) | 223.77(221.155,226.655) |
| 8 | 229.2(225.528,231.83) | 0.11(0.075,0.125) | 229.315(225.71,231.87) |
| 9 | 266.25(262.32,269.9) | 0.11(0.09,0.153) | 266.44(262.48,270.09) |
| 10 | 265.565(262.665,267.167) | 0.12(0.112,0.14) | 265.78(262.802,267.32) |
| 11 | 280.89(279.818,286.23) | 0.085(0.08,0.14) | 281.015(280.05,286.363) |
| 12 | 286.305(283.575,290.59) | 0.14(0.123,0.17) | 286.545(283.8,290.857) |
| 13 | 293.635(288.247,295.518) | 0.14(0.1,0.18) | 293.81(288.548,295.685) |
| 14 | 294.41(287.753,300.593) | 0.125(0.103,0.14) | 294.735(287.867,300.715) |
| 15 | 312.465(309.808,315.228) | 0.135(0.09,0.178) | 312.77(309.968,315.358) |
| 16 | 314.9(311.79,318.95) | 0.16(0.115,0.222) | 315.09(312.093,319.1) |

Table 2. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 0.692(0.625,0.792) | 5(5,8) | 2(1,2.75) | 0.1(0.1,100) | 0.1(0.1,0.4) | 0(0,0) | 0(0,0) |
| **2** | 0.884(0.664,0.906) | 5(4,5) | 1(1,2) | 0.1(0.1,100) | 0.1(0.1,0.4) | 0(0,0) | 0(0,0) |
| **3** | 2.998(2.531,3.429) | 12(2,12) | 1(1,1.75) | 100(0.1,100) | 0.4(0.1,0.4) | 0.01(0,0.01) | 0(0,0) |
| **4** | 3.573(3.503,3.7) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **5** | 4.55(4.309,5.022) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **6** | 4.488(4.286,4.869) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **7** | 6.261(5.898,6.895) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **8** | 5.951(5.51,6.22) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **9** | 7.417(6.954,7.844) | 6(1.25,12) | 2(1,2) | 100(0.325,100) | 0.4(0.125,0.4) | 0(0,0.01) | 0(0,0) |
| **10** | 7.453(6.825,8.711) | 4.5(4,11) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.008) | 0(0,0) |
| **11** | 7.81(7.412,7.924) | 12(5,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |
| **12** | 7.575(7.539,7.698) | 8(3.25,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0.01) | 0(0,0) |
| **13** | 8.578(8.148,8.772) | 4(1.75,7.5) | 1(1,1.75) | 100(0.325,100) | 0.4(0.125,0.4) | 0(0,0) | 0(0,0) |
| **14** | 8.463(7.949,8.823) | 9(4,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **15** | 8.762(8.591,9.078) | 4(2.25,7) | 1(1,1) | 100(3.25,100) | 0.4(0.225,0.4) | 0(0,0) | 0(0,0) |
| **16** | 8.6(8.37,8.869) | 4(3,4) | 1(1,3) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0) | 0(0,0) |

Table 3. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

#### 2.1.3.2 Frontal Region (1)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 4)

The User, System and Elapsed Time group by number of HPCA (Table 5): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

The Model fitting parameters group by number of HPCA (Table 6): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HCPA | MSPE | | **Correlation** | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0(0,0.001) | 0.126(0.126,0.126) | 1(0.999,1) | 0.936(0.935,0.936) |
| **2** | 0.002(0,0.006) | 0.063(0.057,0.095) | 0.999(0.997,1) | 0.968(0.952,0.971) |
| **3** | 0.034(0.011,0.056) | 0.366(0.36,0.371) | 0.983(0.972,0.994) | 0.801(0.798,0.807) |
| **4** | 0.151(0.096,0.158) | 0.316(0.301,0.316) | 0.921(0.918,0.951) | 0.827(0.827,0.836) |
| **5** | 0.175(0.175,0.175) | 0.727(0.727,0.727) | 0.908(0.908,0.908) | 0.585(0.585,0.585) |
| **6** | 0.174(0.174,0.174) | 0.943(0.943,0.943) | 0.909(0.909,0.909) | 0.462(0.462,0.462) |
| **7** | 0.328(0.301,0.328) | 0.777(0.756,0.866) | 0.819(0.819,0.84) | 0.555(0.487,0.566) |
| **8** | 0.302(0.271,0.314) | 0.84(0.818,0.917) | 0.835(0.828,0.854) | 0.528(0.454,0.539) |
| **9** | 0.345(0.329,0.388) | 0.984(0.973,1.022) | 0.809(0.782,0.819) | 0.439(0.4,0.444) |
| **10** | 0.376(0.353,0.386) | 0.807(0.804,0.81) | 0.79(0.783,0.804) | 0.535(0.532,0.539) |
| **11** | 0.45(0.441,0.601) | 0.931(0.93,0.947) | 0.741(0.639,0.748) | 0.43(0.319,0.435) |
| **12** | 0.403(0.37,0.431) | 0.907(0.901,0.942) | 0.772(0.754,0.793) | 0.452(0.419,0.461) |
| **13** | 0.453(0.413,0.486) | 0.89(0.814,0.895) | 0.739(0.717,0.766) | 0.454(0.451,0.491) |
| **14** | 0.427(0.413,0.476) | 0.918(0.833,0.919) | 0.757(0.723,0.766) | 0.444(0.435,0.479) |
| **15** | 0.474(0.446,0.509) | 1.035(0.945,1.085) | 0.725(0.7,0.744) | 0.372(0.309,0.385) |
| **16** | 0.491(0.374,0.507) | 1.099(1.027,1.162) | 0.713(0.701,0.79) | 0.349(0.341,0.37) |

Table 4. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for frontal region brain.

| HPCA | **Time (s)** | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 95.55(94.568,96.358) | 0.08(0.06,0.097) | 95.78(94.678,96.447) |
| **2** | 95.51(94.533,97.14) | 0.07(0.045,0.087) | 95.565(94.612,97.222) |
| **3** | 143.905(143.158,145.185) | 0.08(0.063,0.102) | 144.015(143.225,145.305) |
| **4** | 156.825(154.452,163.548) | 0.115(0.087,0.14) | 156.89(154.563,164.062) |
| **5** | 187.61(184.643,190.002) | 0.075(0.063,0.1) | 187.705(184.955,190.142) |
| **6** | 190.755(188.99,191.795) | 0.08(0.053,0.135) | 190.835(189.088,191.923) |
| **7** | 220.5(216.895,222.17) | 0.135(0.093,0.183) | 220.635(217.065,222.34) |
| **8** | 225.53(224.603,228.035) | 0.095(0.07,0.13) | 225.715(224.675,228.185) |
| **9** | 269.96(268.198,272.765) | 0.135(0.112,0.165) | 270.145(268.365,272.968) |
| **10** | 270.205(268.855,274.842) | 0.125(0.105,0.155) | 270.445(268.973,275.013) |
| **11** | 299.08(295.595,305.542) | 0.125(0.09,0.147) | 299.3(295.74,305.75) |
| **12** | 304.335(298.033,310.727) | 0.135(0.08,0.158) | 304.46(298.25,310.942) |
| **13** | 305.765(302.532,309.892) | 0.135(0.11,0.155) | 305.92(302.957,310.098) |
| **14** | 302.06(298.79,303.965) | 0.115(0.087,0.14) | 302.225(299.035,304.17) |
| **15** | 332.72(330.39,335.655) | 0.165(0.135,0.19) | 332.96(330.552,335.84) |
| **16** | 326.68(325.358,329.56) | 0.155(0.15,0.198) | 326.91(325.505,329.818) |

Table 5. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

| HPCA | **Min_Error** | **Optimum** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 1.344(0.987,1.355) | 5(5,5) | 3(1.25,3) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **2** | 1.468(1.183,1.608) | 6(5,8) | 1.5(1,2.75) | 5.05(0.1,100) | 0.2(0.1,0.4) | 0(0,0) | 0(0,0) |
| **3** | 4.932(4.617,5.082) | 1(1,1) | 1.5(1,2) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **4** | 5.02(4.847,5.263) | 12(4,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |
| **5** | 5.794(5.709,6.1) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **6** | 5.776(5.336,6.175) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **7** | 9.085(8.691,9.351) | 4(4,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.01) | 0(0,0) |
| **8** | 8.048(7.4,8.769) | 12(6,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **9** | 10.122(9.518,10.319) | 8(5,11.75) | 1(1,1.75) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0.01) | 0(0,0) |
| **10** | 9.243(9.078,9.417) | 7.5(4,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **11** | 10.668(9.741,11.998) | 6(4,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.01) | 0(0,0.008) |
| **12** | 10.457(10.265,10.997) | 8(4,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **13** | 11.347(11.254,11.841) | 3.5(1.25,8) | 1(1,1) | 55(0.325,100) | 0.35(0.125,0.4) | 0(0,0) | 0(0,0) |
| **14** | 11.283(11.014,11.597) | 3.5(1.5,6.25) | 1(1,1) | 10(2.575,100) | 0.3(0.15,0.4) | 0(0,0) | 0(0,0) |
| **15** | 11.756(11.404,12.145) | 5.5(1.5,8) | 1(1,1.75) | 55(2.575,100) | 0.35(0.15,0.4) | 0(0,0) | 0(0,0) |
| **16** | 11.283(11.045,11.405) | 5.5(4,10.25) | 1(1,2.5) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0.008) | 0(0,0) |

Table 6. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

#### 2.1.3.3 Central Region (2)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 7)

The User, System and Elapsed Time group by number of HPCA (Table 8): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 9): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | **Train** | **Test** | **Train** | **Test** |
| 1 | 0(0,0.001) | 0.046(0.046,0.053) | 1(1,1) | 0.977(0.973,0.977) |
| 2 | 0(0,0.001) | 0.044(0.044,0.049) | 1(0.999,1) | 0.978(0.975,0.978) |
| 3 | 0.027(0.009,0.068) | 0.171(0.168,0.221) | 0.986(0.965,0.995) | 0.911(0.885,0.913) |
| 4 | 0.048(0.027,0.069) | 0.169(0.169,0.228) | 0.976(0.965,0.986) | 0.913(0.882,0.913) |
| 5 | 0.086(0.086,0.086) | 0.402(0.402,0.402) | 0.956(0.956,0.956) | 0.788(0.788,0.788) |
| 6 | 0.086(0.086,0.086) | 0.41(0.41,0.41) | 0.956(0.956,0.956) | 0.784(0.784,0.784) |
| 7 | 0.137(0.137,0.141) | 0.441(0.424,0.441) | 0.929(0.927,0.929) | 0.761(0.761,0.779) |
| 8 | 0.136(0.136,0.164) | 0.42(0.39,0.44) | 0.929(0.914,0.929) | 0.772(0.761,0.792) |
| 9 | 0.197(0.185,0.217) | 0.415(0.412,0.45) | 0.896(0.884,0.903) | 0.775(0.763,0.777) |
| 10 | 0.193(0.189,0.197) | 0.449(0.417,0.461) | 0.898(0.896,0.901) | 0.764(0.759,0.775) |
| 11 | 0.258(0.218,0.263) | 0.483(0.473,0.504) | 0.861(0.858,0.884) | 0.731(0.718,0.737) |
| 12 | 0.213(0.211,0.258) | 0.494(0.471,0.509) | 0.887(0.861,0.888) | 0.725(0.715,0.739) |
| 13 | 0.24(0.189,0.257) | 0.618(0.608,0.641) | 0.871(0.862,0.9) | 0.654(0.638,0.667) |
| 14 | 0.257(0.241,0.289) | 0.616(0.606,0.648) | 0.862(0.843,0.871) | 0.661(0.634,0.665) |
| 15 | 0.242(0.185,0.294) | 0.702(0.635,0.715) | 0.87(0.84,0.902) | 0.61(0.589,0.636) |
| 16 | 0.294(0.224,0.327) | 0.661(0.63,0.695) | 0.84(0.82,0.88) | 0.629(0.622,0.633) |

Table 7. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for central region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| 1 | 70.32(68.812,71.565) | 0.045(0.023,0.08) | 70.42(69.155,71.75) |
| 2 | 68.69(67.558,69.393) | 0.03(0.02,0.045) | 68.785(67.597,69.475) |
| 3 | 146.825(145.66,147.255) | 0.11(0.065,0.118) | 147.065(145.9,147.32) |
| 4 | 142.945(141.553,145.535) | 0.07(0.045,0.08) | 143.03(141.645,145.835) |
| 5 | 180.79(179.892,182.508) | 0.11(0.07,0.138) | 180.885(179.943,182.69) |
| 6 | 176.195(175.48,177.915) | 0.09(0.08,0.097) | 176.345(175.608,178.015) |
| 7 | 214.72(214.553,215.67) | 0.1(0.08,0.11) | 214.93(214.642,215.763) |
| 8 | 216.76(214.187,218.365) | 0.095(0.08,0.17) | 216.855(214.357,218.458) |
| 9 | 262.21(259.643,265.375) | 0.12(0.112,0.16) | 262.32(259.89,265.573) |
| 10 | 263.77(259.072,266.665) | 0.105(0.1,0.118) | 263.91(259.205,266.798) |
| 11 | 291.36(286.702,295.69) | 0.16(0.125,0.2) | 291.66(286.815,296.205) |
| 12 | 291.295(287.503,297.415) | 0.13(0.11,0.182) | 291.485(287.67,297.73) |
| 13 | 287.85(284.567,290.38) | 0.14(0.115,0.198) | 288.1(284.76,290.535) |
| 14 | 284.445(281.037,286.245) | 0.135(0.115,0.165) | 284.68(281.22,286.41) |
| 15 | 315.955(314.29,319.553) | 0.145(0.13,0.19) | 316.19(314.48,319.848) |
| 16 | 313.405(311.62,315.738) | 0.15(0.13,0.167) | 313.805(311.913,315.9) |

Table 8. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for central region of the brain.

| HPCA | **Min_Error** | **Optimum** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.524(0.452,0.553) | 5(5,7.5) | 2(1,2.75) | 0.1(0.1,75.25) | 0.1(0.1,0.35) | 0(0,0) | 0(0,0) |
| **2** | 0.505(0.442,0.516) | 5(5,8) | 2(1,2.75) | 0.1(0.1,100) | 0.1(0.1,0.4) | 0(0,0) | 0(0,0) |
| **3** | 1.96(1.8,2.215) | 7(2,12) | 1(1,1.75) | 0.1(0.1,100) | 0.1(0.1,0.4) | 0.005(0,0.01) | 0(0,0) |
| **4** | 2.007(1.841,2.151) | 10.5(5,12) | 1(1,1) | 50.05(0.1,100) | 0.25(0.1,0.4) | 0.01(0,0.01) | 0(0,0) |
| **5** | 2.913(2.67,3.043) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **6** | 3.043(2.753,3.261) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **7** | 4.263(4.016,4.351) | 12(11.25,12) | 2(1.25,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **8** | 4.202(4.084,4.412) | 12(12,12) | 2(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **9** | 5.339(4.879,5.592) | 6(4,11) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0.01) | 0(0,0) |
| **10** | 5.185(4.983,5.606) | 9.5(3,11) | 1(1,1) | 10(10,77.5) | 0.3(0.3,0.375) | 0.005(0,0.01) | 0(0,0) |
| **11** | 6.182(5.968,6.599) | 12(11.25,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **12** | 6.156(6.047,6.363) | 10(4,12) | 1.5(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **13** | 6.701(6.504,6.84) | 10(5,11.75) | 1(1,2.75) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0,0.01) | 0(0,0) |
| **14** | 6.876(6.329,7.133) | 11.5(5.75,12) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **15** | 7.107(6.927,7.172) | 6(4,9.5) | 2(1,3) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0.008) | 0(0,0) |
| **16** | 7.239(6.893,7.649) | 11(8,12) | 1(1,2.5) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0,0.01) | 0(0,0) |

Table 9. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for central region of the brain..

#### 2.1.3.4 Occipital Region (3)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 10)

The User, System and Elapsed Time group by number of HPCA (Table 11): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 12): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HCPA | MSPE | | Correlation | |
|---|---|---|---|---|
| | **Train** | **Test** | **Train** | **Test** |
| 1 | 0(0,0) | 0.002(0.001,0.002) | 1(1,1) | 0.999(0.999,0.999) |
| 2 | 0.01(0.009,0.012) | 0.281(0.253,0.31) | 0.995(0.994,0.996) | 0.86(0.85,0.87) |
| 3 | 0.012(0.01,0.014) | 0.285(0.245,0.316) | 0.994(0.993,0.995) | 0.858(0.847,0.877) |
| 4 | 0.078(0.057,0.078) | 0.4(0.256,0.429) | 0.96(0.96,0.971) | 0.781(0.768,0.867) |
| 5 | 0.069(0.036,0.08) | 0.353(0.273,0.42) | 0.965(0.959,0.982) | 0.806(0.773,0.858) |
| 6 | 0.092(0.092,0.111) | 0.496(0.487,0.619) | 0.953(0.943,0.953) | 0.74(0.664,0.742) |
| 7 | 0.106(0.096,0.115) | 0.501(0.489,0.554) | 0.945(0.941,0.951) | 0.738(0.708,0.741) |
| 8 | 0.185(0.185,0.202) | 0.688(0.685,0.715) | 0.902(0.893,0.903) | 0.6(0.597,0.604) |
| 9 | 0.187(0.187,0.208) | 0.684(0.684,0.713) | 0.901(0.89,0.901) | 0.601(0.601,0.601) |
| 10 | 0.371(0.362,0.378) | 0.844(0.765,0.851) | 0.793(0.788,0.798) | 0.433(0.432,0.519) |
| 11 | 0.354(0.354,0.375) | 0.821(0.821,0.842) | 0.803(0.79,0.803) | 0.448(0.436,0.448) |
| 12 | 0.367(0.367,0.373) | 0.902(0.902,0.908) | 0.795(0.791,0.795) | 0.38(0.376,0.38) |
| 13 | 0.382(0.368,0.388) | 0.913(0.901,0.918) | 0.786(0.782,0.795) | 0.376(0.375,0.382) |
| 14 | 0.388(0.388,0.422) | 1.008(1,1.009) | 0.782(0.76,0.782) | 0.334(0.328,0.35) |
| 15 | 0.43(0.387,0.434) | 1.02(1.013,1.043) | 0.755(0.752,0.783) | 0.333(0.324,0.347) |
| 16 | 0.428(0.41,0.45) | 0.985(0.973,1.012) | 0.756(0.741,0.768) | 0.339(0.33,0.343) |

Table 10. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| 1 | 73.99(73.703,74.662) | 0.045(0.033,0.09) | 74.19(73.82,74.735) |
| 2 | 97.26(95.125,98.603) | 0.05(0.03,0.075) | 97.335(95.252,98.625) |
| 3 | 121.24(120.955,122.175) | 0.075(0.06,0.105) | 121.36(121.055,122.27) |
| 4 | 158.97(155.26,161.55) | 0.085(0.065,0.107) | 159.095(155.685,161.63) |
| 5 | 153.09(149.975,155.527) | 0.085(0.063,0.105) | 153.215(150.053,155.633) |
| 6 | 188.6(185.438,192.718) | 0.1(0.083,0.11) | 188.7(185.55,192.83) |
| 7 | 189.01(184.708,190.642) | 0.11(0.072,0.155) | 189.12(185.083,190.73) |
| 8 | 215.275(212.437,220.477) | 0.125(0.093,0.16) | 215.495(212.597,220.617) |
| 9 | 206.62(205.715,207.52) | 0.095(0.09,0.15) | 206.81(205.823,207.633) |
| 10 | 237.12(231.073,238.997) | 0.1(0.075,0.12) | 237.195(231.22,239.125) |
| 11 | 218.29(215.97,219.05) | 0.095(0.082,0.133) | 218.4(216.185,219.18) |
| 12 | 268.29(265.86,270.997) | 0.13(0.08,0.182) | 268.43(265.982,271.165) |
| 13 | 248.595(245.99,252.612) | 0.11(0.087,0.127) | 248.725(246.07,252.783) |
| 14 | 274.22(271.423,295.435) | 0.125(0.103,0.22) | 274.64(271.897,297.185) |
| 15 | 464.355(400.745,538.865) | 0.255(0.2,0.37) | 469.43(402.81,540.52) |
| 16 | 584.05(580.36,591.583) | 0.285(0.245,0.36) | 585.795(581.923,593.19) |

Table 11. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | **Min_Error** | **Optimum** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.019(0.017,0.02) | 5(2,5) | 1(1,2) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **2** | 0.969(0.852,1.128) | 12(12,12) | 2(2,2.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **3** | 1.086(0.972,1.241) | 12(6.75,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **4** | 4.553(4.108,5.357) | 12(7.25,12) | 2(1,2) | 100(3.25,100) | 0.4(0.225,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **5** | 4.802(4.33,5.421) | 8.5(4,12) | 2(1,3.5) | 100(32.5,100) | 0.4(0.325,0.4) | 0.005(0,0.01) | 0(0,0) |
| **6** | 4.872(4.723,5.013) | 7.5(2,11.75) | 1(1,1.75) | 1(1,77.5) | 0.2(0.2,0.375) | 0.005(0,0.01) | 0(0,0) |
| **7** | 5.043(4.636,5.665) | 10.5(2,11) | 1(1,1) | 5.5(1,10) | 0.25(0.2,0.3) | 0.01(0,0.01) | 0(0,0) |
| **8** | 6.641(6.351,6.978) | 5(3.5,9.75) | 1(1,1) | 1(0.1,10) | 0.2(0.1,0.3) | 0(0,0.008) | 0(0,0) |
| **9** | 7.152(6.466,7.643) | 1(1,11) | 1(1,1) | 0.1(0.1,10) | 0.1(0.1,0.3) | 0(0,0.01) | 0(0,0) |
| **10** | 9.18(8.982,9.368) | 12(9,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **11** | 9.243(9.091,9.746) | 4(4,11) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.008) | 0(0,0) |
| **12** | 9.249(8.845,9.442) | 4(4,7) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **13** | 9.176(8.668,9.459) | 12(5,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |
| **14** | 9.803(9.531,10.297) | 6(4,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.01) | 0(0,0) |
| **15** | 10.252(9.911,10.387) | 12(4,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |
| **16** | 10.175(9.962,10.293) | 10(8,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |

Table 12. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

#### 2.1.3.5 Parietal (4)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 13)

The User, System and Elapsed Time group by number of HPCA (Table 14): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 15): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HCPA | MSPE | | Correlation | |
|---|---|---|---|---|
| | **Train** | **Test** | **Train** | **Test** |
| 1 | 0(0,0) | 0.038(0.037,0.038) | 1(1,1) | 0.981(0.981,0.981) |
| 2 | 0(0,0) | 0.059(0.059,0.059) | 1(1,1) | 0.97(0.97,0.97) |
| 3 | 0.06(0.016,0.06) | 0.125(0.125,0.152) | 0.969(0.969,0.992) | 0.936(0.922,0.936) |
| 4 | 0.027(0.001,0.027) | 0.187(0.145,0.219) | 0.986(0.986,1) | 0.905(0.889,0.926) |
| 5 | 0.082(0.077,0.085) | 0.34(0.33,0.392) | 0.958(0.956,0.961) | 0.826(0.798,0.828) |
| 6 | 0.091(0.079,0.097) | 0.314(0.305,0.325) | 0.954(0.95,0.959) | 0.838(0.832,0.842) |
| 7 | 0.125(0.118,0.135) | 0.308(0.302,0.314) | 0.935(0.93,0.939) | 0.838(0.836,0.84) |
| 8 | 0.123(0.112,0.139) | 0.301(0.289,0.321) | 0.936(0.928,0.942) | 0.842(0.831,0.847) |
| 9 | 0.164(0.148,0.191) | 0.321(0.317,0.33) | 0.914(0.899,0.923) | 0.827(0.822,0.829) |
| 10 | 0.159(0.143,0.188) | 0.364(0.362,0.365) | 0.917(0.901,0.925) | 0.803(0.803,0.806) |
| 11 | 0.207(0.186,0.224) | 0.436(0.336,0.454) | 0.891(0.881,0.902) | 0.759(0.749,0.815) |
| 12 | 0.232(0.201,0.24) | 0.443(0.374,0.471) | 0.876(0.871,0.894) | 0.755(0.739,0.793) |
| 13 | 0.237(0.161,0.267) | 0.539(0.516,0.553) | 0.873(0.856,0.916) | 0.701(0.689,0.711) |
| 14 | 0.213(0.161,0.242) | 0.524(0.443,0.534) | 0.887(0.87,0.916) | 0.714(0.702,0.752) |
| 15 | 0.26(0.188,0.292) | 0.572(0.522,0.589) | 0.86(0.841,0.901) | 0.676(0.668,0.71) |
| 16 | 0.255(0.239,0.262) | 0.526(0.494,0.569) | 0.863(0.859,0.872) | 0.706(0.678,0.727) |

Table 13. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| 1 | 121.48(119.882,124.642) | 0.09(0.083,0.148) | 121.975(120.285,125.055) |
| 2 | 119.41(117.62,120.535) | 0.12(0.078,0.17) | 119.875(118.11,121.197) |
| 3 | 274.445(272.063,277.975) | 0.175(0.063,0.24) | 275.035(272.765,278.803) |
| 4 | 200.72(199.383,203.535) | 0.125(0.102,0.178) | 201.225(200.232,203.927) |
| 5 | 357.05(354.743,359.603) | 0.17(0.145,0.218) | 357.88(355.452,360.51) |
| 6 | 349.665(345.548,353.182) | 0.185(0.173,0.208) | 350.275(346.478,353.978) |
| 7 | 432.955(426.86,439.942) | 0.215(0.17,0.258) | 433.79(427.92,440.813) |
| 8 | 429.29(421.5,438.21) | 0.23(0.197,0.265) | 430.285(422.19,439.267) |
| 9 | 533.27(517.603,534.82) | 0.27(0.197,0.278) | 534.58(518.293,536.305) |
| 10 | 519.435(514.43,527.802) | 0.215(0.175,0.337) | 520.58(515.74,528.692) |
| 11 | 563.67(561.878,573.67) | 0.24(0.162,0.25) | 564.365(562.575,574.41) |
| 12 | 567.975(559.682,575.592) | 0.18(0.142,0.24) | 568.585(560.47,576.295) |
| 13 | 572.335(567.233,574.612) | 0.235(0.193,0.335) | 573.105(568.095,575.31) |
| 14 | 585.51(576.208,592.298) | 0.195(0.142,0.248) | 586.22(576.853,593.08) |
| 15 | 635.805(633.02,640.603) | 0.275(0.22,0.327) | 636.56(633.828,641.463) |
| 16 | 639.4(630.075,656.25) | 0.215(0.193,0.273) | 640.07(630.952,657.033) |

Table 14. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

| HPCA | **Min_Error** | **Optimum** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.432(0.404,0.513) | 5(5,5) | 1.5(1,2) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **2** | 0.461(0.384,0.481) | 5(5,5.75) | 1.5(1,2) | 0.1(0.1,0.775) | 0.1(0.1,0.175) | 0(0,0) | 0(0,0) |
| **3** | 1.761(1.713,1.841) | 12(6.75,12) | 1(1,1.75) | 100(25.075,100) | 0.4(0.175,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **4** | 1.62(1.537,1.793) | 7(2,9) | 1(1,2) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.005(0,0.01) | 0(0,0) |
| **5** | 2.504(2.388,2.642) | 11(1.75,11.75) | 1(1,2) | 10(2.575,100) | 0.3(0.15,0.4) | 0.01(0,0.01) | 0(0,0) |
| **6** | 2.332(2.203,2.486) | 12(11,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **7** | 3.463(3.267,3.679) | 12(11,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **8** | 3.498(3.418,3.748) | 11(8,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |
| **9** | 4.553(4.479,4.724) | 4(3.25,11) | 1(1,2) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0.008) | 0(0,0) |
| **10** | 4.552(4.3,4.663) | 12(11.25,12) | 1.5(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **11** | 5.716(5.611,5.842) | 10(4,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **12** | 5.755(5.55,5.916) | 12(12,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **13** | 5.989(5.657,6.092) | 8(5,11.75) | 1(1,3) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.01) | 0(0,0) |
| **14** | 6.189(5.866,6.424) | 10.5(5,12) | 1(1,3) | 100(25.75,100) | 0.4(0.25,0.4) | 0.01(0,0.01) | 0(0,0) |
| **15** | 6.445(6.243,6.692) | 8(4.25,10.25) | 1(1,2.75) | 55(10,100) | 0.35(0.3,0.4) | 0(0,0.008) | 0(0,0) |
| **16** | 6.471(6.278,6.68) | 11(9,11.75) | 1(1,1.75) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |

Table 15. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

#### 2.1.3.6 Left Temporal (5)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 16)

The User, System and Elapsed Time group by number of HPCA (Table 17): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 18): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HCPA | MSPE | | Correlation | |
|---|---|---|---|---|
| | **Train** | **Test** | **Train** | **Test** |
| 1 | 0(0,0) | 0.015(0.015,0.015) | 1(1,1) | 0.992(0.992,0.993) |
| 2 | 0.016(0.014,0.028) | 0.479(0.369,0.533) | 0.992(0.986,0.993) | 0.759(0.74,0.812) |
| 3 | 0.031(0.03,0.032) | 0.449(0.391,0.503) | 0.984(0.984,0.985) | 0.772(0.744,0.798) |
| 4 | 0.071(0.033,0.095) | 0.469(0.421,0.52) | 0.964(0.951,0.984) | 0.746(0.712,0.767) |
| 5 | 0.104(0.1,0.118) | 0.51(0.465,0.516) | 0.947(0.939,0.948) | 0.709(0.708,0.756) |
| 6 | 0.166(0.166,0.166) | 0.813(0.811,0.813) | 0.913(0.913,0.913) | 0.566(0.565,0.566) |
| 7 | 0.185(0.185,0.187) | 0.818(0.799,0.818) | 0.902(0.902,0.902) | 0.561(0.561,0.562) |
| 8 | 0.268(0.267,0.283) | 0.947(0.941,0.973) | 0.855(0.847,0.856) | 0.433(0.428,0.438) |
| 9 | 0.279(0.279,0.279) | 0.933(0.931,0.946) | 0.849(0.849,0.849) | 0.44(0.435,0.442) |
| 10 | 0.37(0.37,0.382) | 0.998(0.998,1.009) | 0.794(0.786,0.794) | 0.342(0.336,0.347) |
| 11 | 0.386(0.386,0.386) | 1.016(1.015,1.025) | 0.783(0.783,0.783) | 0.329(0.329,0.329) |
| 12 | 0.419(0.419,0.42) | 1.075(1.068,1.077) | 0.762(0.761,0.762) | 0.271(0.264,0.282) |
| 13 | 0.423(0.423,0.432) | 1.076(1.067,1.079) | 0.759(0.753,0.76) | 0.271(0.26,0.277) |
| 14 | 0.516(0.511,0.516) | 1.24(1.218,1.241) | 0.695(0.695,0.699) | 0.19(0.19,0.192) |
| 15 | 0.516(0.513,0.519) | 1.242(1.22,1.243) | 0.695(0.693,0.697) | 0.188(0.187,0.189) |
| 16 | 0.524(0.524,0.528) | 1.278(1.269,1.28) | 0.689(0.686,0.689) | 0.151(0.151,0.152) |

Table 16. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| 1 | 125.38(124.665,126.722) | 0.1(0.072,0.188) | 125.885(124.92,127.045) |
| 2 | 202.82(198.693,205.827) | 0.15(0.06,0.198) | 203.475(199.13,206.4) |
| 3 | 294.33(287.265,298.83) | 0.14(0.115,0.18) | 294.92(287.712,299.675) |
| 4 | 288.405(285.075,292.317) | 0.17(0.125,0.203) | 289.155(285.585,293.08) |
| 5 | 349.74(341.647,354.168) | 0.175(0.153,0.197) | 350.7(342.77,355.352) |
| 6 | 356.13(351.65,359.147) | 0.22(0.143,0.283) | 356.575(352.44,359.81) |
| 7 | 415.24(411.383,418.195) | 0.165(0.123,0.23) | 415.75(411.952,419.182) |
| 8 | 450.155(446.803,455.758) | 0.235(0.163,0.265) | 450.975(447.36,456.193) |
| 9 | 503.89(494.803,515.692) | 0.15(0.135,0.19) | 504.495(495.368,516.228) |
| 10 | 465.605(463.703,472.972) | 0.2(0.172,0.243) | 466.325(464.46,473.635) |
| 11 | 503.055(500.398,506.45) | 0.24(0.2,0.265) | 504.255(501.382,507.693) |
| 12 | 545.485(539.507,551.778) | 0.24(0.21,0.25) | 546.1(540.595,552.39) |
| 13 | 556.815(547.28,562.213) | 0.205(0.183,0.218) | 557.445(547.935,562.987) |
| 14 | 585.765(583.23,595.007) | 0.215(0.18,0.272) | 586.675(583.753,595.878) |
| 15 | 595.375(588.203,597.305) | 0.28(0.19,0.36) | 596.115(588.835,598.375) |
| 16 | 615.175(613.58,618.99) | 0.23(0.213,0.25) | 615.825(614.15,619.79) |

Table 17. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

| HPCA | **Min_Error** | **Optimum** | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.18(0.16,0.184) | 5(5,5) | 1(1,1.75) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **2** | 2.168(1.813,2.381) | 11.5(10.25,12) | 2(1,2) | 55(3.25,100) | 0.35(0.225,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **3** | 2.287(2.083,2.616) | 10.5(9,11.75) | 1(1,2.75) | 5.5(0.325,77.5) | 0.25(0.125,0.375) | 0.01(0.01,0.01) | 0(0,0) |
| **4** | 6.626(6.03,7.552) | 11(11,11.75) | 3(1,4) | 10(10,77.5) | 0.3(0.3,0.375) | 0.01(0.01,0.01) | 0(0,0) |
| **5** | 6.311(5.913,8.319) | 11.5(11,12) | 2(1,3) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **6** | 8.178(7.658,9.422) | 6(6,6) | 1(1,1) | 1(1,1) | 0.2(0.2,0.2) | 0(0,0) | 0(0,0) |
| **7** | 8.721(8.465,9.906) | 6(6,10.75) | 1(1,1) | 1(1,7.75) | 0.2(0.2,0.275) | 0(0,0.01) | 0(0,0) |
| **8** | 9.141(8.698,9.3) | 10(5,11) | 1(1,1) | 1(0.325,10) | 0.2(0.125,0.3) | 0.01(0,0.01) | 0(0,0) |
| **9** | 9.7(9.188,10.663) | 6(5,8.25) | 1(1,1) | 0.55(0.1,1) | 0.15(0.1,0.2) | 0(0,0.008) | 0(0,0) |
| **10** | 10.871(10.187,12.159) | 7(5,10.75) | 1(1,1) | 0.1(0.1,7.75) | 0.1(0.1,0.275) | 0.005(0,0.01) | 0(0,0) |
| **11** | 10.927(10.528,11.208) | 5(5,5.75) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **12** | 11.039(10.795,11.289) | 5.5(2,9.75) | 1(1,1) | 0.1(0.1,1) | 0.1(0.1,0.2) | 0(0,0.01) | 0(0,0) |
| **13** | 11.271(10.791,11.696) | 6(2.75,10.75) | 1(1,1) | 1(0.325,7.75) | 0.2(0.125,0.275) | 0(0,0.01) | 0(0,0) |
| **14** | 12.273(12.061,12.671) | 5.5(3,7) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0(0,0) |
| **15** | 11.613(11.409,12.138) | 4(3,7) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0(0,0) |
| **16** | 11.75(11.227,11.929) | 3.5(3,6.75) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0(0,0) |

Table 18. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

#### 2.1.3.7 Right Temporal (6)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 19)

The User, System and Elapsed Time group by number of HPCA (Table 20): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 21): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HCPA | MSPE | | Correlation | |
|---|---|---|---|---|
| | **Train** | **Test** | **Train** | **Test** |
| 1 | 0(0,0) | 0.063(0.063,0.063) | 1(1,1) | 0.968(0.968,0.968) |
| 2 | 0.007(0.004,0.013) | 0.227(0.212,0.234) | 0.997(0.994,0.998) | 0.882(0.879,0.89) |
| 3 | 0.077(0.077,0.088) | 0.329(0.327,0.37) | 0.961(0.955,0.961) | 0.824(0.804,0.825) |
| 4 | 0.077(0.053,0.077) | 0.282(0.257,0.404) | 0.96(0.96,0.973) | 0.848(0.774,0.862) |
| 5 | 0.015(0.015,0.015) | 0.447(0.447,0.537) | 0.993(0.993,0.993) | 0.752(0.719,0.756) |
| 6 | 0.053(0.024,0.149) | 0.467(0.444,0.529) | 0.973(0.922,0.988) | 0.741(0.703,0.759) |
| 7 | 0.22(0.22,0.22) | 0.459(0.459,0.488) | 0.883(0.883,0.883) | 0.738(0.728,0.738) |
| 8 | 0.276(0.276,0.296) | 0.479(0.472,0.506) | 0.85(0.839,0.85) | 0.727(0.712,0.727) |
| 9 | 0.324(0.324,0.343) | 0.556(0.506,0.601) | 0.822(0.81,0.822) | 0.668(0.644,0.703) |
| 10 | 0.359(0.359,0.359) | 0.745(0.642,0.745) | 0.801(0.801,0.801) | 0.528(0.528,0.605) |
| 11 | 0.382(0.381,0.466) | 0.727(0.637,0.876) | 0.786(0.73,0.787) | 0.545(0.436,0.604) |
| 12 | 0.409(0.409,0.486) | 0.776(0.722,0.976) | 0.768(0.716,0.768) | 0.492(0.367,0.537) |
| 13 | 0.427(0.427,0.502) | 0.777(0.738,0.967) | 0.757(0.705,0.757) | 0.49(0.359,0.524) |
| 14 | 0.433(0.433,0.433) | 0.841(0.841,0.87) | 0.753(0.753,0.753) | 0.453(0.436,0.453) |
| 15 | 0.459(0.459,0.459) | 0.897(0.883,0.9) | 0.735(0.735,0.735) | 0.428(0.427,0.428) |
| 16 | 0.454(0.454,0.454) | 0.854(0.821,0.855) | 0.739(0.739,0.739) | 0.455(0.452,0.468) |

Table 19. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| 1 | 122.58(120.777,123.17) | 0.08(0.065,0.132) | 122.805(120.947,123.365) |
| 2 | 187.405(183.807,189.842) | 0.08(0.06,0.095) | 187.6(184.075,190.085) |
| 3 | 316(308.48,321.705) | 0.135(0.11,0.19) | 316.305(308.993,322.132) |
| 4 | 292.425(290.21,293.37) | 0.13(0.095,0.223) | 292.75(290.587,293.828) |
| 5 | 360.51(354.398,364.865) | 0.16(0.12,0.258) | 360.86(355.035,365.158) |
| 6 | 366.595(364.973,368.71) | 0.14(0.102,0.173) | 367.015(365.413,369.12) |
| 7 | 475.41(468.057,480.182) | 0.19(0.16,0.225) | 476.14(468.795,480.968) |
| 8 | 470.695(464.493,474.79) | 0.2(0.167,0.24) | 471.39(465.642,475.475) |
| 9 | 545.57(535.125,560.993) | 0.23(0.183,0.265) | 546.285(535.743,561.835) |
| 10 | 559.395(548.497,573.71) | 0.19(0.155,0.25) | 560.25(549.15,574.675) |
| 11 | 613.955(605.148,619.005) | 0.275(0.195,0.37) | 615.19(606.01,620.918) |
| 12 | 610.25(601.325,616.26) | 0.235(0.188,0.267) | 611.105(602.45,617.197) |
| 13 | 613.53(609.288,624.188) | 0.25(0.197,0.31) | 614.355(610.585,624.97) |
| 14 | 617.85(608.253,621.952) | 0.205(0.193,0.277) | 618.555(609.03,623.845) |
| 15 | 685.05(669.635,694.07) | 0.385(0.313,0.45) | 687.175(672.178,696.335) |
| 16 | 664.235(653.742,672.14) | 0.265(0.215,0.365) | 665.13(654.727,673.798) |

Table 20. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 0.684(0.612,0.765) | 5(5,5) | 2(2,2) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **2** | 1.27(1.194,1.478) | 3(3,4) | 1(1,2) | 10(10,100) | 0.3(0.3,0.4) | 0(0,0) | 0(0,0) |
| **3** | 2.957(2.904,3.107) | 4.5(1.25,10.25) | 1(1,1) | 5.5(0.1,77.5) | 0.25(0.1,0.375) | 0(0,0.008) | 0(0,0) |
| **4** | 5.737(5.476,6.624) | 1(1,9.5) | 1.5(1,2) | 0.1(0.1,75.25) | 0.1(0.1,0.35) | 0(0,0.008) | 0(0,0) |
| **5** | 6.175(5.963,6.379) | 1(1,7.25) | 3(3,3) | 0.1(0.1,75.025) | 0.1(0.1,0.325) | 0(0,0) | 0(0,0) |
| **6** | 6.972(6.598,7.128) | 8(1.75,8.75) | 4(1.5,5) | 100(0.1,100) | 0.4(0.1,0.4) | 0(0,0.008) | 0(0,0) |
| **7** | 8.482(8.218,8.681) | 1(1,8.5) | 1(1,1) | 0.1(0.1,7.525) | 0.1(0.1,0.25) | 0(0,0.008) | 0(0,0) |
| **8** | 9.151(8.727,9.466) | 2(1,8.75) | 1(1,1) | 0.1(0.1,10) | 0.1(0.1,0.3) | 0(0,0.008) | 0(0,0) |
| **9** | 8.974(8.748,9.273) | 9(3,11) | 1(1,1) | 0.1(0.1,10) | 0.1(0.1,0.3) | 0.01(0.003,0.01) | 0(0,0) |
| **10** | 9.932(9.286,10.624) | 9(2,9) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0,0.01) | 0(0,0) |
| **11** | 11.162(10.265,11.788) | 8(1.25,10) | 1(1,1) | 1(0.325,100) | 0.2(0.125,0.4) | 0(0,0.01) | 0(0,0) |
| **12** | 10.628(10.249,11.143) | 8.5(1.75,9) | 1(1,1) | 0.1(0.1,77.5) | 0.1(0.1,0.375) | 0.005(0,0.01) | 0(0,0) |
| **13** | 10.873(10.734,11.14) | 6.5(1.75,8.75) | 1(1,1) | 0.1(0.1,75.025) | 0.1(0.1,0.325) | 0(0,0.008) | 0(0,0) |
| **14** | 11.166(10.649,11.326) | 1(1,8) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0.008) | 0(0,0) |
| **15** | 11.089(10.548,11.274) | 9(6,9.75) | 1(1,1) | 1(0.1,1) | 0.2(0.1,0.2) | 0.01(0,0.01) | 0(0,0) |
| **16** | 11.58(11.08,11.949) | 4.5(1.25,8.25) | 1(1,1) | 0.1(0.1,1) | 0.1(0.1,0.2) | 0(0,0.008) | 0(0,0) |

Table 21. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

#### 2.1.3.8 Figures

The MSPE over Number of HPCA group by Regions: Figure 14

The Correlation over Number of HPCA group by Regions: Figure 15

The Elapsed Time over Number of HPCA group by Regions: Figure 16

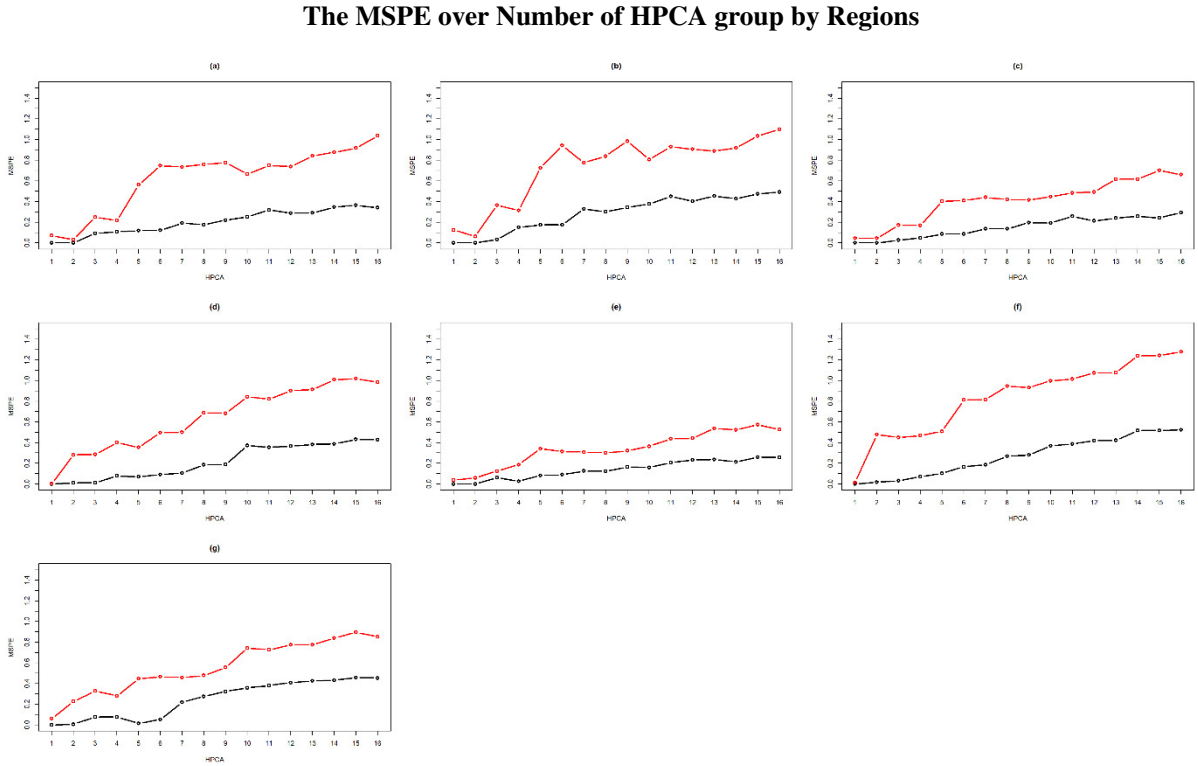



Figure 14. (a-g) Median of mean square prediction error (MSPE) for train (black solid line) and test (red solid line) in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

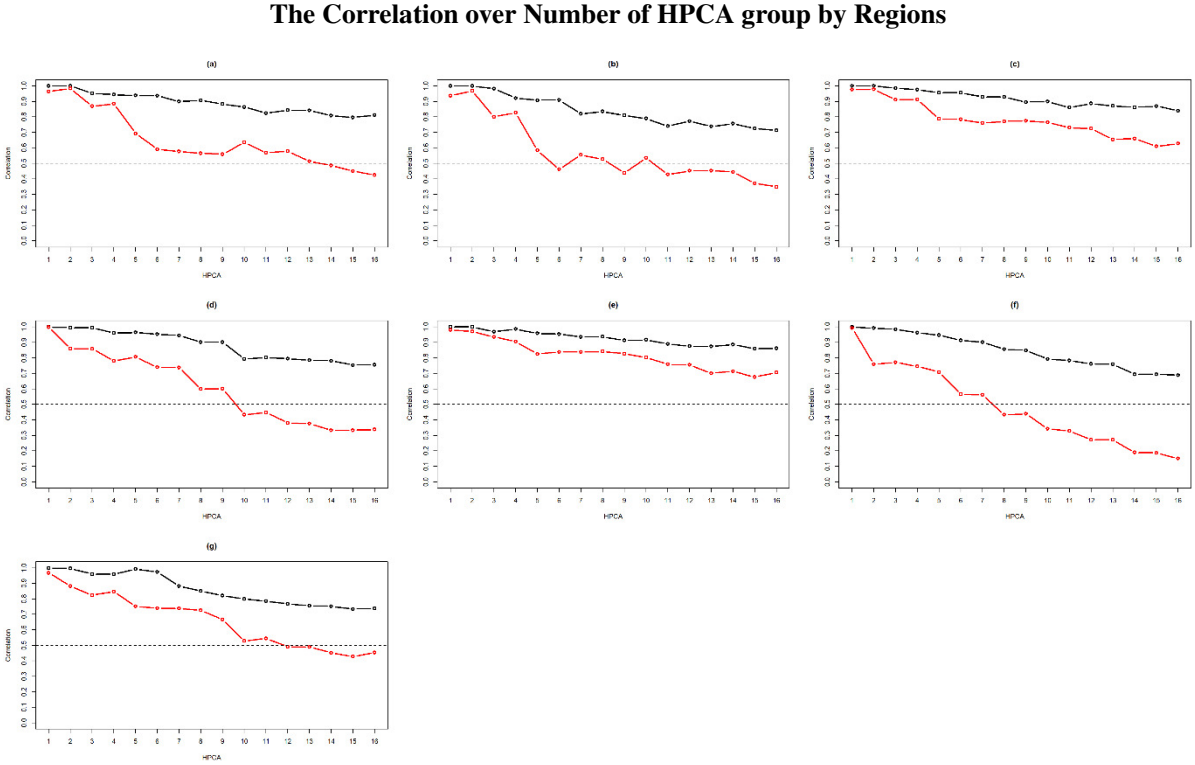



Figure 15. (a-g) Median of correlation for train (black solid line) and test (red solid line) in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively

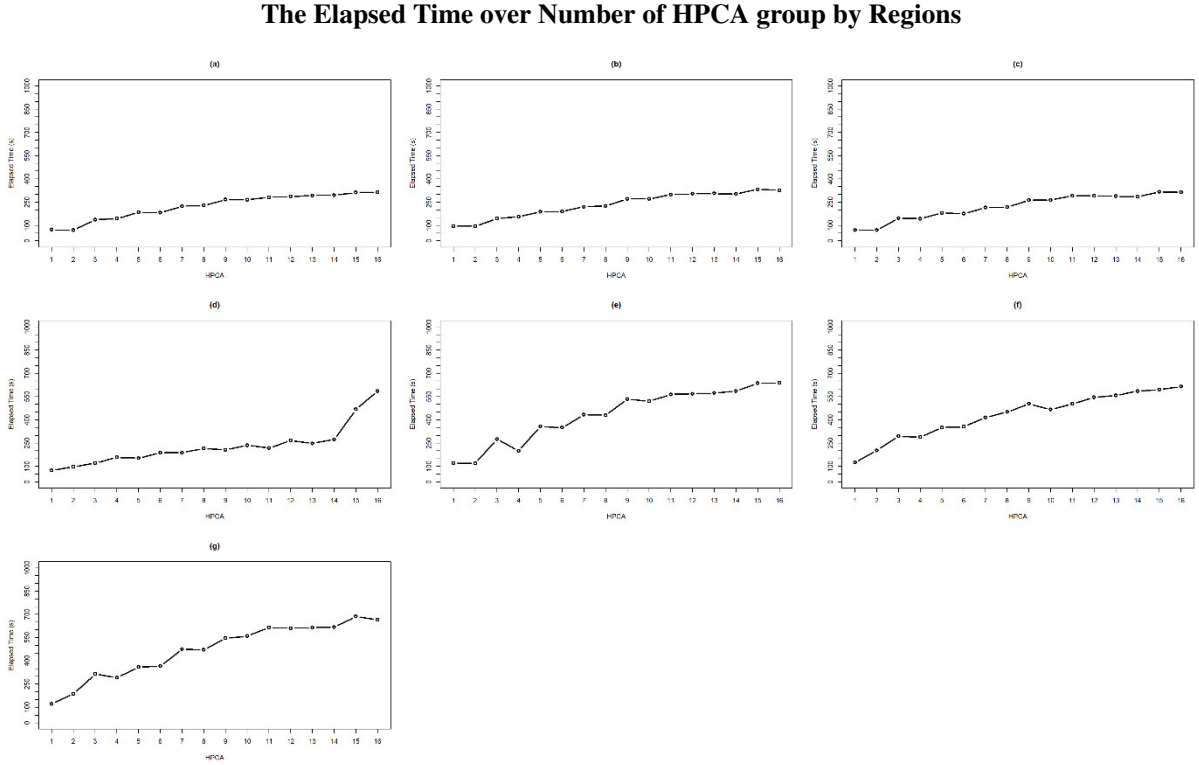



Figure 16. (a-g) Median of elapsed time in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively

*2.1.4. Conclusion .*
According to the Figure 14, the MSPE increased by adding HPCA from 1 to KLM in all regions. It also indicates that the difference between training and testing exists. The Figure 15 shows the correlation. The highest correlation is in the first HPCA in all regions fro both training and testing datasets. The elapsed time is also increasing by adding HPCA.(Figure 16)
We conclude that the first HPCA has the best performance based on the MSPE, correlation and elapsed times in all region of the brain.

### *2.2. Target Stimuli*

*2.2.1. The HPCA Decomposition*

#### 2.2.1.1 The Functional dimension

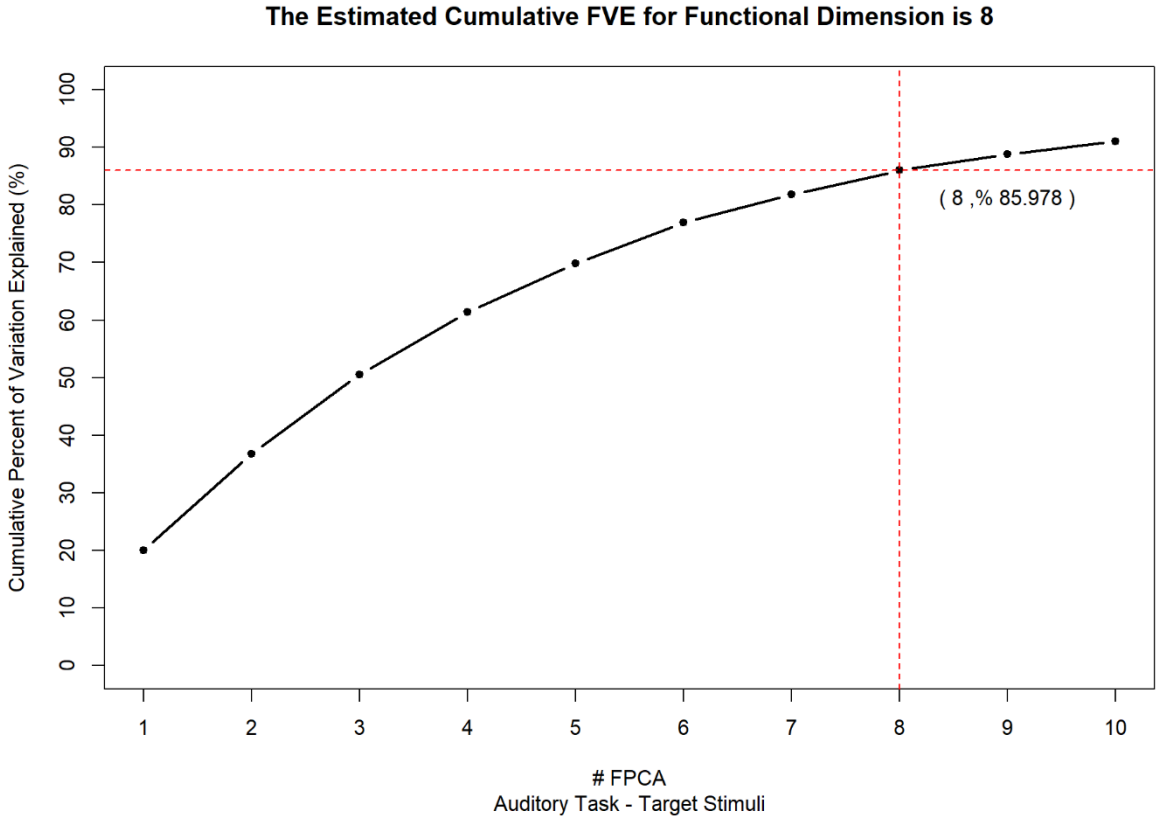



Figure 17. The estimated cumulative fraction of variations (FVE) for functional dimension.

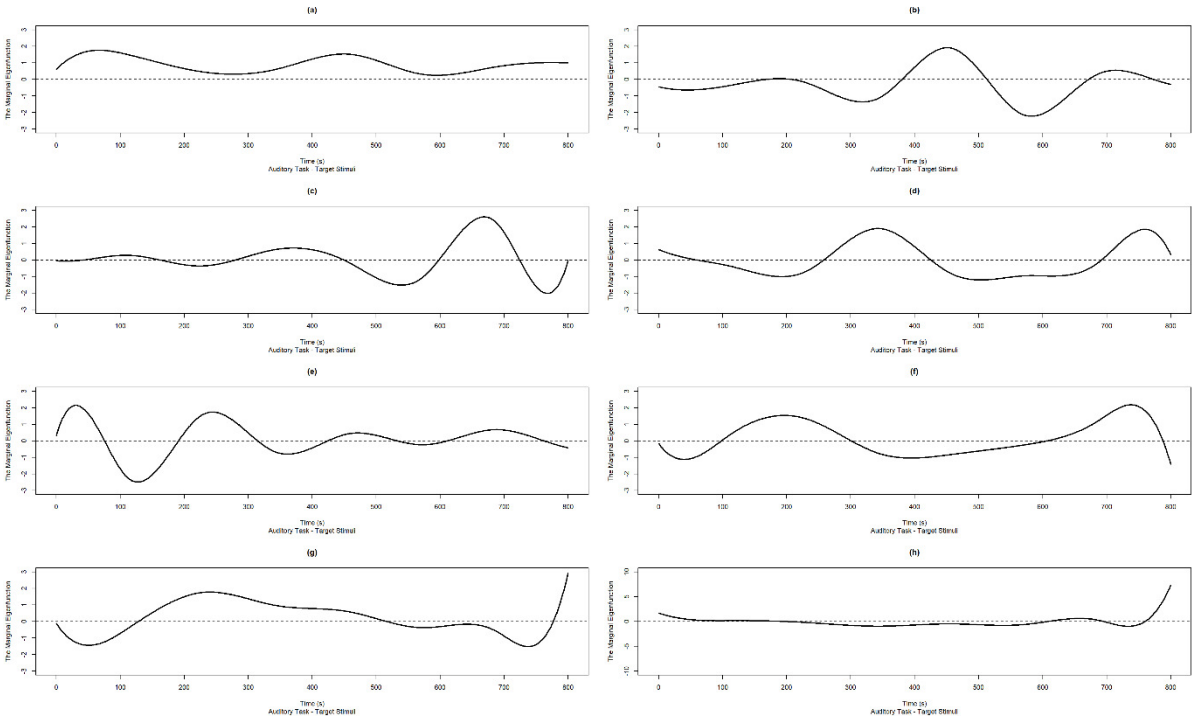



Figure 18. (a, h) Estimated first to eight leading functional marginal eigenfunctions.

According to the Figure 17, the first eight marginal functional principal component analysis (FPCA) capture at least 85% of variation in this dimension. The Figure 18 plots estimated first to eight leading functional marginal eigenfunctions on the x-axis (time).

#### 2.2.1.2 The Longitudinal dimension

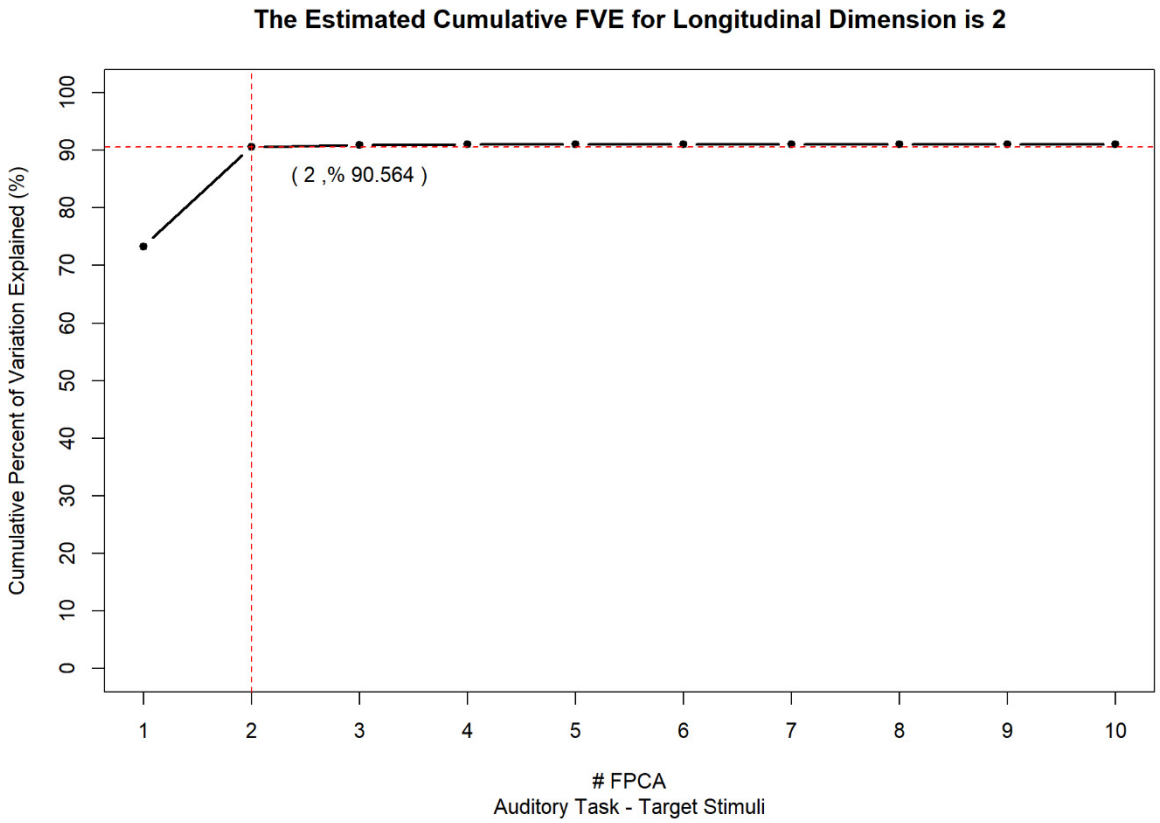



Figure 19. The estimated cumulative fraction of variations (FVE) for longitudinal dimension.

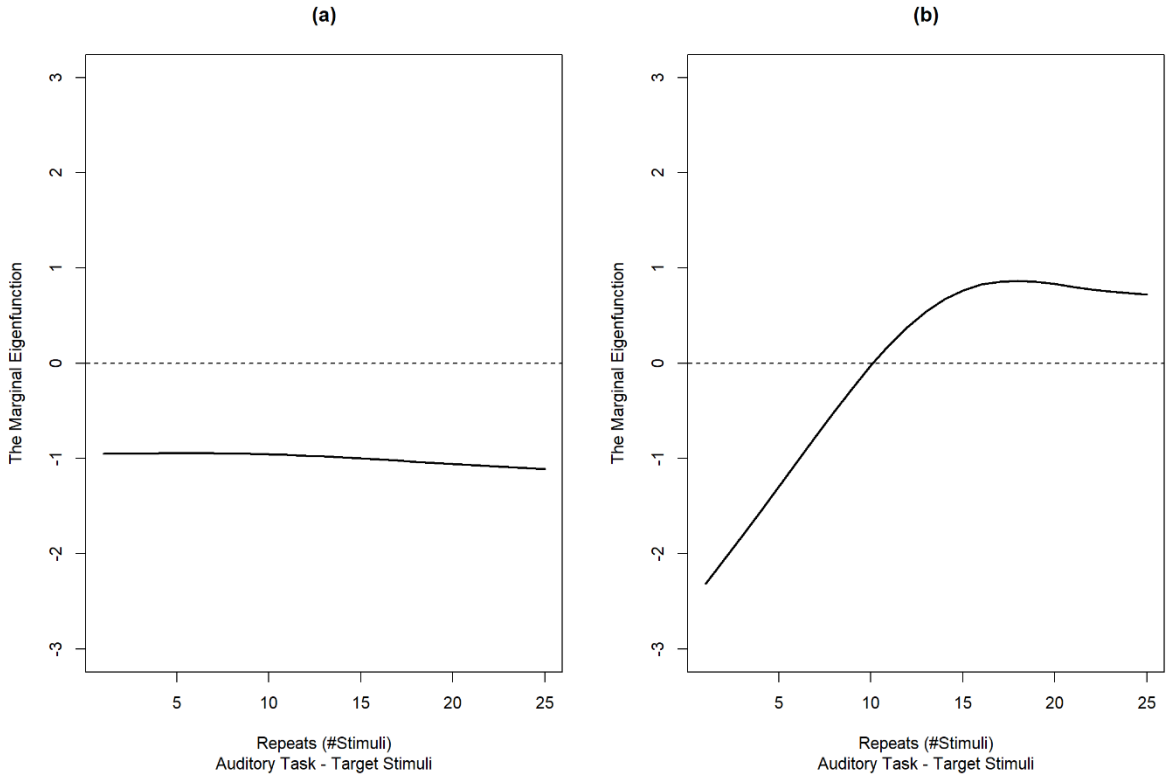



Figure 20. Estimated (a) first and (b) second leading longitudinal marginal eigenfunctions.

According to the Figure 19, the first and second marginal functional principal component analysis (FPCA) capture at least 90% of variation in this dimension. The Figure 20 plots estimated first leading longitudinal marginal eigenfunctions on the receptions.

#### 2.2.1.3 The Regional dimension

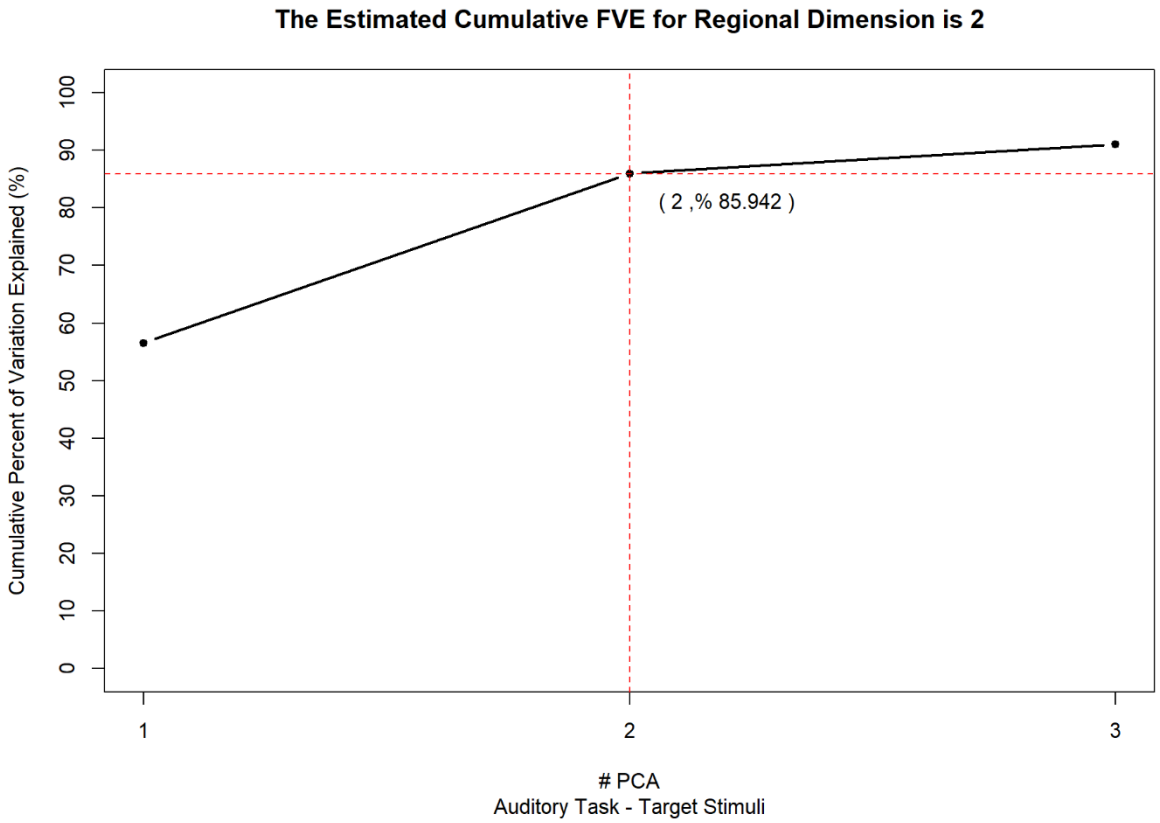



Figure 21. The estimated cumulative fraction of variations (FVE) for regional dimension.

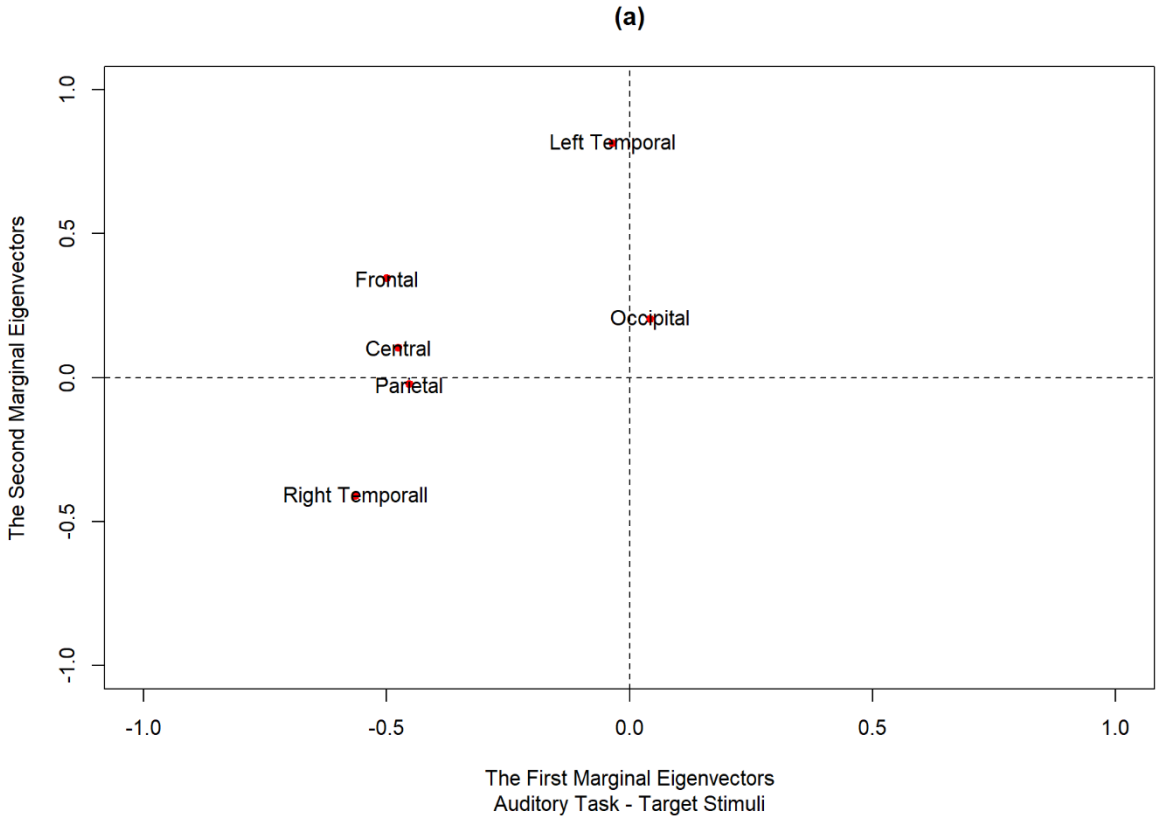



Figure 22. Estimated first and second leading regional marginal eigenvectors.

According to the Figure 21, the first and second marginal principal component analysis (PCA) capture at least nearly 85% of variation in this dimension. The Figure 22 plots estimated first and second leading regional marginal eigenvectors.

*2.2.2. The Reconstructed of the Response .*
The fof regression were conducted group by the number of HPCA and the regions. In the following part, we show the reconstructed ERPs for each subject (in gray) based on the number of HPCA. In this trial, we have 32 HPCA. We also show the point-wise mean and mean ± standard deviation. ( Whole Brain: Figure 23, Frontal region (1): Figure 24, Central Region (2): Figure 25, Occipital Region (3): Figure 26, Parietal Region (4): Figure 27, Left Temporal (5): Figure 28, Right Temporal (6): Figure 29 ).

#### 2.2.2.1 Whole Brain

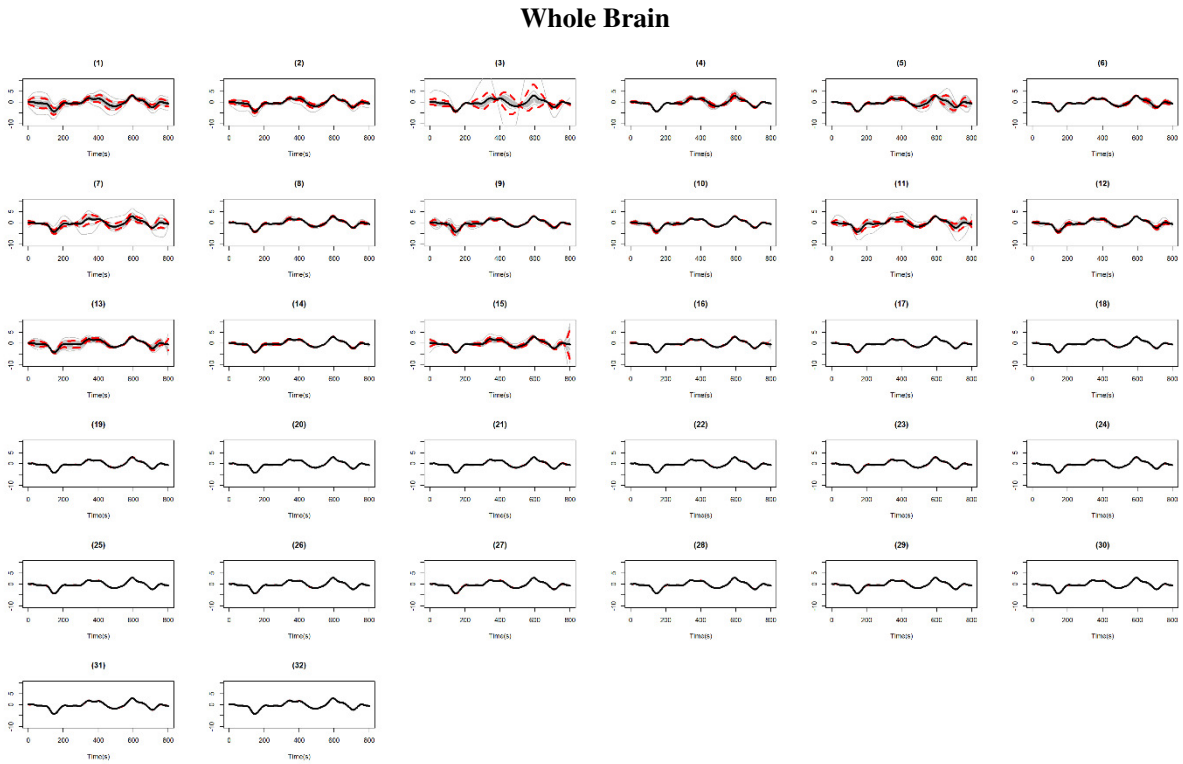



Figure 23. (1-32) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for whole region of the Brain

#### 2.2.2.2 Frontal Region (1)

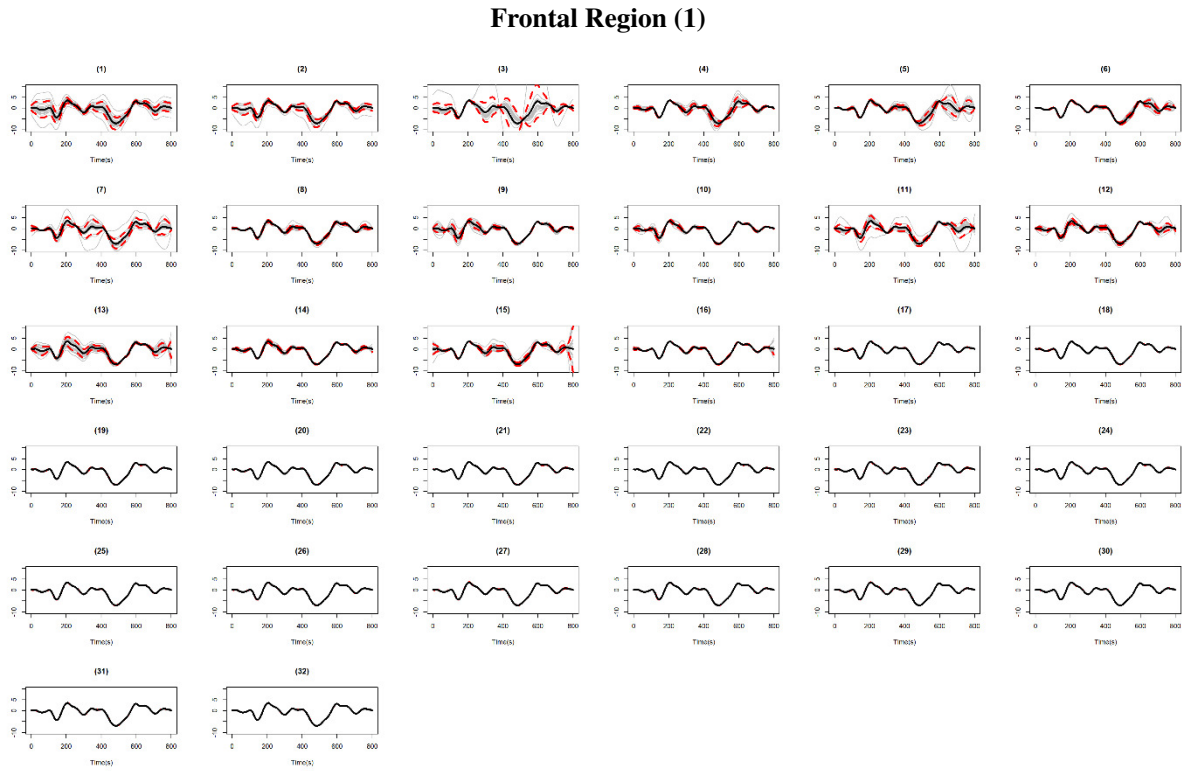



Figure 24. (1-32) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for frontal region of the Brain.

#### 2.2.2.3 Central Region (2)

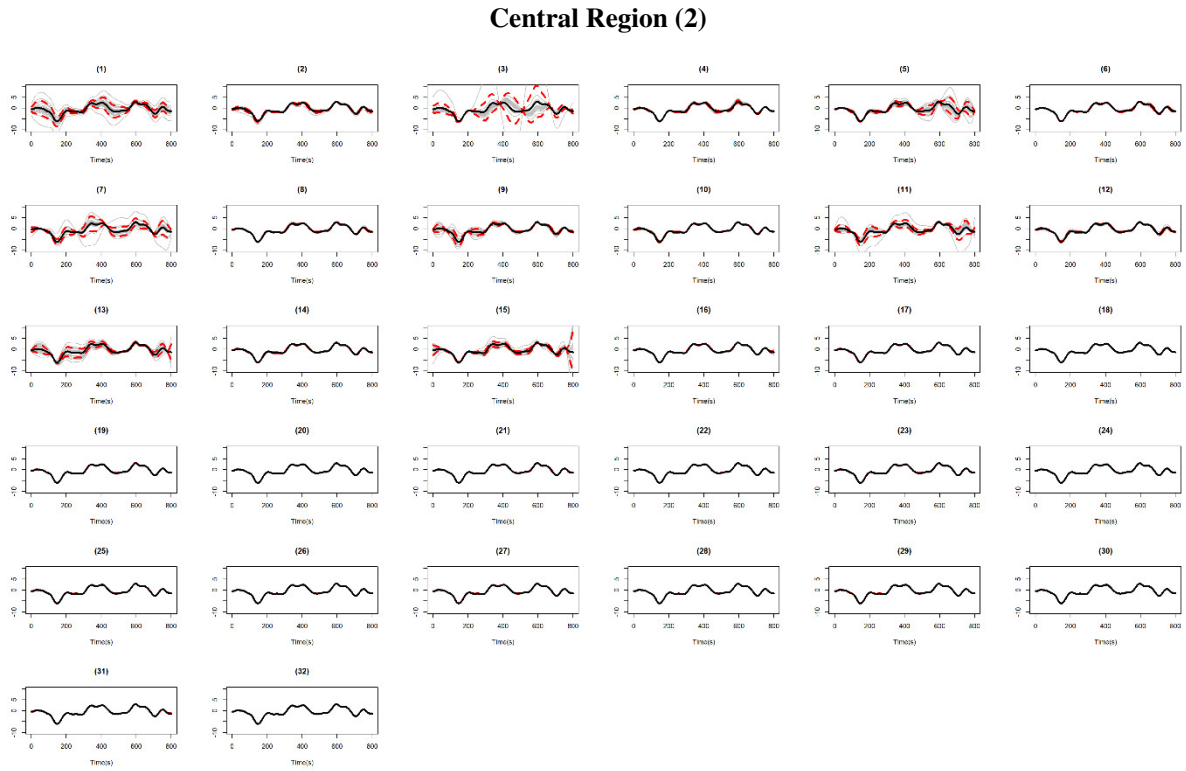



Figure 25. (1-32) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for central region of the Brain.

#### 2.2.2.4 Occipital Region (3)

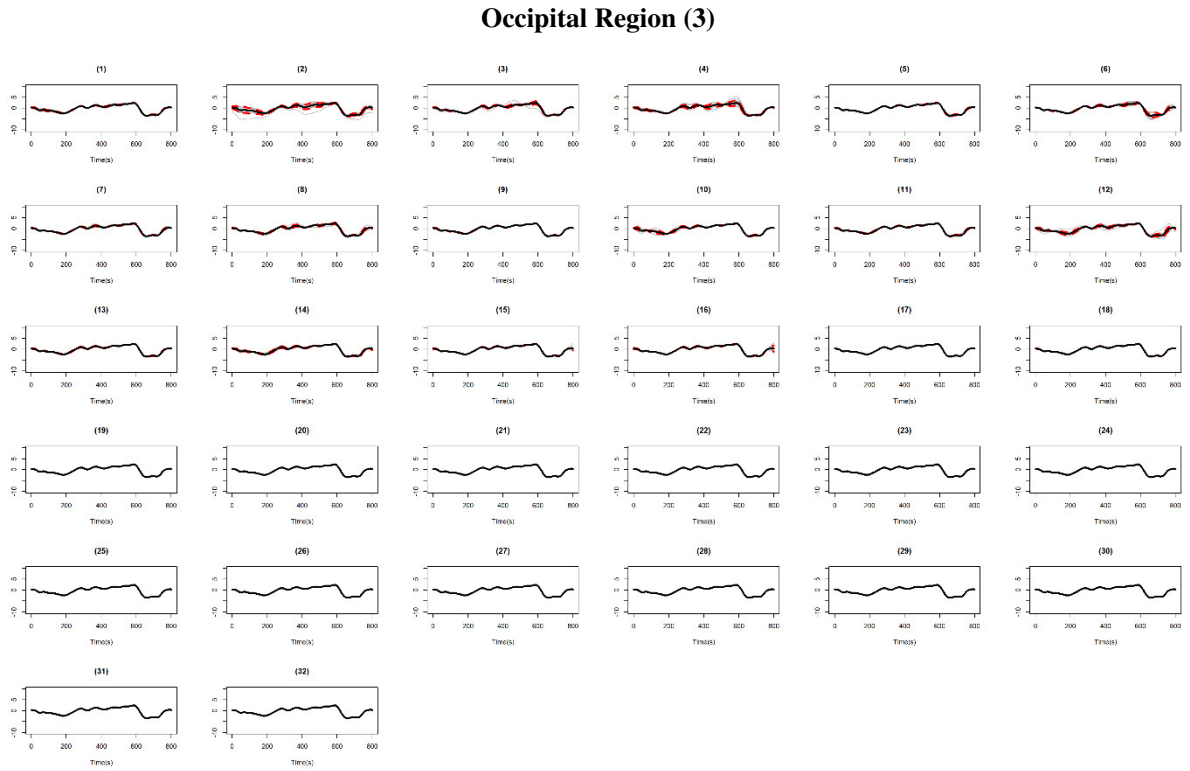



Figure 26. (1-32) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for occipital region of the Brain.

#### 2.2.2.5 Parietal Region (4)

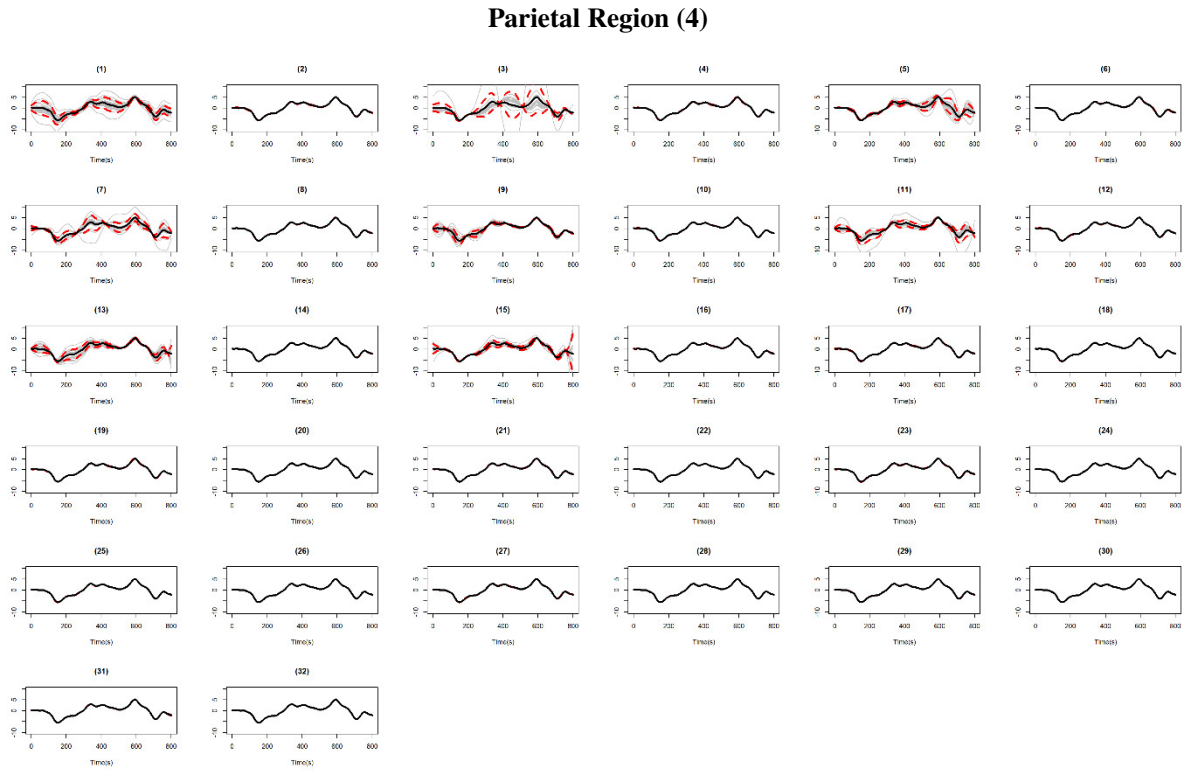



Figure 27. (1-32) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for parietal region of the Brain.

#### 2.2.2.6 Left Temporal (5)

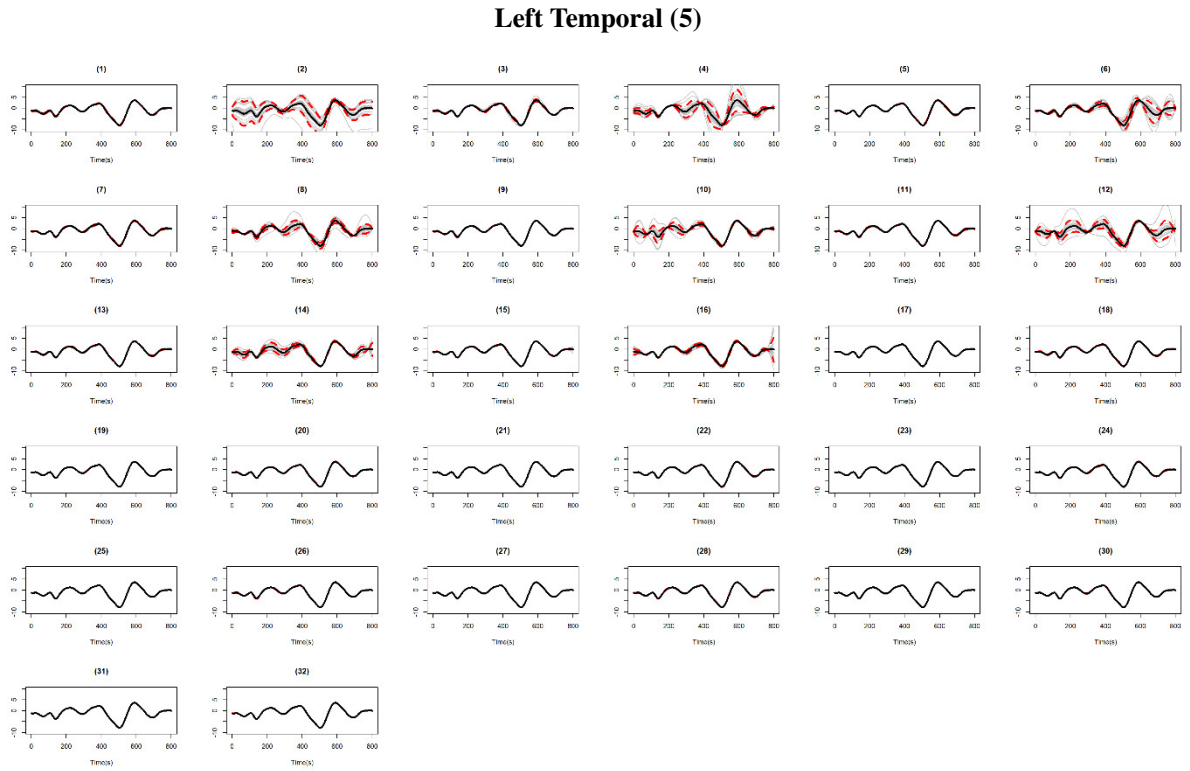



Figure 28. (1-32) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for left temporal region of the Brain.

#### 2.2.2.7 Right Temporal (6)

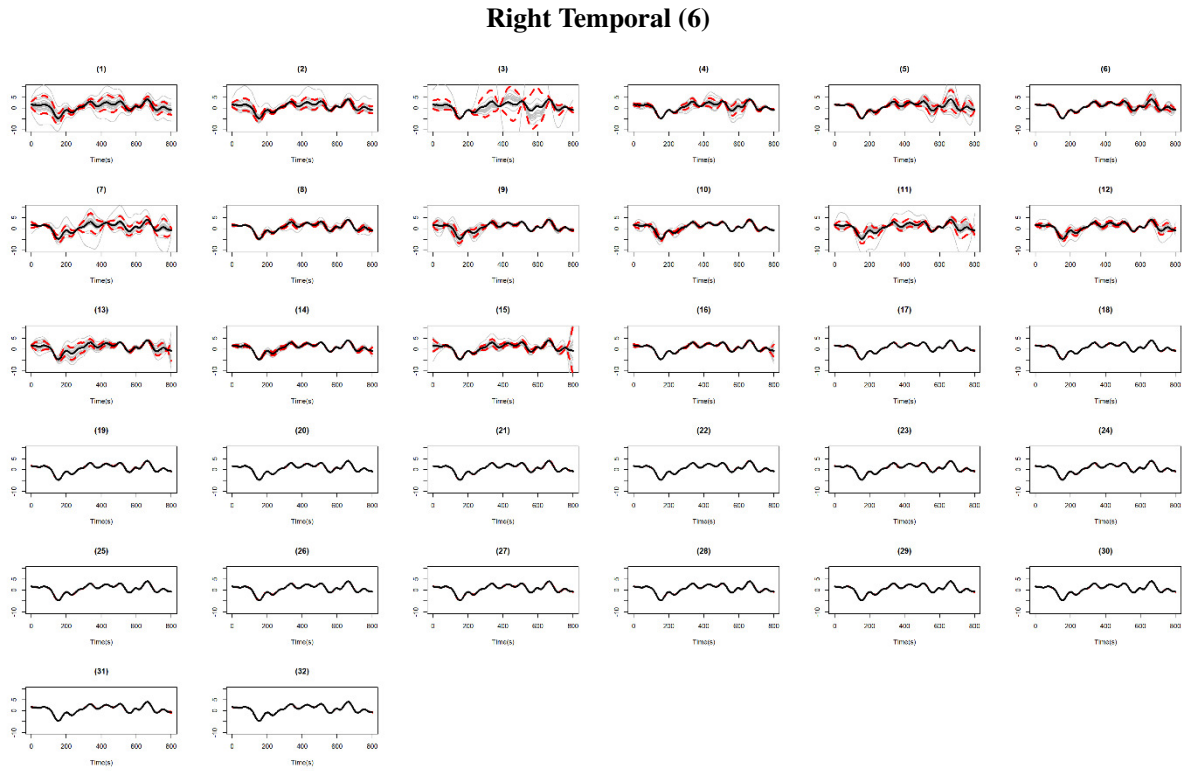



Figure 29. (1-32) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for right temporal region of the Brain.

*2.2.3. The function-on-function result* .
The fof regression result group by the region of the brain and the number of hybrid principal component analysis (HPCA) were reported.

#### 2.2.3.1 Whole Brain

The MSPE and Correlation group by number of HPCA, Train and Test (Table 22)

The User, System and Elapsed Time group by number of HPCA (Table 23): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 24): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | **MSPE** | | **Correlation** | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.013(0.004,0.022) | 0.218(0.171,0.244) | 0.993(0.989,0.998) | 0.888(0.874,0.912) |
| **2** | 0.003(0.001,0.004) | 0.052(0.05,0.056) | 0.998(0.998,1) | 0.974(0.972,0.975) |
| **3** | 0.051(0.051,0.111) | 0.449(0.417,0.554) | 0.974(0.943,0.974) | 0.746(0.685,0.768) |
| **4** | 0.056(0.056,0.056) | 0.34(0.34,0.342) | 0.972(0.971,0.972) | 0.813(0.811,0.813) |
| **5** | 0.178(0.176,0.178) | 0.699(0.699,0.759) | 0.907(0.907,0.908) | 0.57(0.536,0.57) |
| **6** | 0.194(0.194,0.261) | 0.703(0.671,0.877) | 0.898(0.859,0.898) | 0.566(0.461,0.591) |
| **7** | 0.138(0.128,0.138) | 0.64(0.64,0.917) | 0.929(0.929,0.934) | 0.613(0.464,0.613) |
| **8** | 0.145(0.145,0.161) | 0.7(0.693,0.861) | 0.925(0.916,0.925) | 0.573(0.493,0.586) |
| **9** | 0.215(0.205,0.222) | 0.701(0.647,0.72) | 0.886(0.882,0.891) | 0.573(0.557,0.611) |
| **10** | 0.227(0.207,0.29) | 0.736(0.736,0.744) | 0.879(0.843,0.89) | 0.546(0.536,0.546) |
| **11** | 0.313(0.249,0.43) | 0.799(0.762,0.868) | 0.843(0.754,0.867) | 0.487(0.389,0.52) |
| **12** | 0.288(0.271,0.374) | 0.821(0.737,0.928) | 0.843(0.818,0.854) | 0.474(0.339,0.535) |
| **13** | 0.345(0.293,0.482) | 0.791(0.753,0.843) | 0.826(0.719,0.846) | 0.492(0.443,0.506) |
| **14** | 0.387(0.329,0.474) | 0.858(0.754,1.034) | 0.8(0.729,0.823) | 0.457(0.21,0.504) |
| **15** | 0.432(0.33,0.508) | 0.828(0.78,0.899) | 0.761(0.701,0.826) | 0.461(0.384,0.475) |
| **16** | 0.508(0.387,0.569) | 0.788(0.753,0.967) | 0.701(0.655,0.795) | 0.467(0.285,0.507) |
| **17** | 0.508(0.435,0.587) | 0.781(0.747,0.978) | 0.701(0.642,0.765) | 0.474(0.286,0.506) |
| **18** | 0.464(0.344,0.567) | 0.863(0.789,0.911) | 0.739(0.657,0.813) | 0.435(0.327,0.471) |
| **19** | 0.482(0.357,0.567) | 0.781(0.747,0.904) | 0.726(0.657,0.801) | 0.473(0.415,0.512) |
| **20** | 0.406(0.35,0.568) | 0.89(0.767,0.973) | 0.778(0.657,0.822) | 0.349(0.274,0.506) |
| **21** | 0.365(0.327,0.506) | 0.879(0.792,0.94) | 0.804(0.707,0.822) | 0.426(0.291,0.479) |
| **22** | 0.507(0.482,0.588) | 0.771(0.737,0.844) | 0.701(0.641,0.729) | 0.482(0.434,0.514) |
| **23** | 0.336(0.328,0.508) | 0.861(0.781,0.93) | 0.817(0.701,0.829) | 0.453(0.318,0.472) |
| **24** | 0.33(0.313,0.507) | 0.92(0.848,0.983) | 0.828(0.706,0.836) | 0.346(0.218,0.441) |
| **25** | 0.375(0.333,0.487) | 0.927(0.8,1.042) | 0.806(0.719,0.833) | 0.306(0.175,0.469) |
| **26** | 0.428(0.32,0.519) | 0.925(0.868,1.05) | 0.77(0.703,0.829) | 0.335(0.239,0.434) |
| **27** | 0.519(0.507,0.572) | 0.784(0.777,0.79) | 0.693(0.654,0.702) | 0.469(0.464,0.476) |
| **28** | 0.507(0.452,0.521) | 0.864(0.778,0.93) | 0.701(0.699,0.751) | 0.379(0.316,0.474) |
| **29** | 0.366(0.329,0.519) | 0.984(0.865,0.991) | 0.803(0.702,0.836) | 0.321(0.233,0.427) |
| **30** | 0.514(0.408,0.572) | 0.789(0.746,0.846) | 0.697(0.653,0.78) | 0.465(0.432,0.505) |
| **31** | 0.507(0.41,0.527) | 0.841(0.77,0.976) | 0.701(0.699,0.778) | 0.409(0.271,0.483) |
| **32** | 0.479(0.41,0.59) | 0.775(0.742,0.849) | 0.721(0.64,0.778) | 0.491(0.433,0.518) |

Table 22. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | Time | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 192.58(190.075,195.48) | 0.195(0.19,0.26) | 193.24(190.708,198.12) |
| **2** | 183.66(180.258,187.238) | 0.205(0.118,0.335) | 184.295(181.478,189.128) |
| **3** | 262.67(260.933,267.11) | 0.15(0.112,0.18) | 263.42(261.817,267.705) |
| **4** | 283.5(278.993,288.568) | 0.155(0.13,0.198) | 284.225(279.705,289.563) |
| **5** | 364.315(361.01,368.888) | 0.2(0.183,0.22) | 365.3(361.833,369.885) |
| **6** | 375.095(363.623,380.488) | 0.23(0.188,0.248) | 376(364.703,381.435) |
| **7** | 455.57(450.985,461.638) | 0.26(0.222,0.315) | 456.635(452.08,464.525) |
| **8** | 468.49(461.908,471.668) | 0.22(0.195,0.23) | 469.52(463.13,472.93) |
| **9** | 535.37(532.48,543.223) | 0.235(0.2,0.28) | 536.74(533.725,544.275) |
| **10** | 543.99(542.78,553.247) | 0.265(0.2,0.325) | 545.01(543.935,554.67) |
| **11** | 558.45(556.647,568.935) | 0.205(0.2,0.255) | 559.54(557.585,570.247) |
| **12** | 600.59(591.723,607.72) | 0.34(0.3,0.598) | 602.03(593.068,609.328) |
| **13** | 593.775(586.515,599.16) | 0.28(0.228,0.375) | 594.915(587.697,600.82) |
| **14** | 586.475(582.255,590.157) | 0.215(0.182,0.315) | 587.995(583.407,591.29) |
| **15** | 644.19(637.803,655.495) | 0.275(0.235,0.322) | 645.255(639.213,657.008) |
| **16** | 659.475(651.853,664.843) | 0.325(0.248,0.352) | 661.265(653.25,667.697) |
| **17** | 648.375(635.745,650.193) | 0.325(0.227,0.375) | 649.54(636.76,651.035) |
| **18** | 643.235(640.655,648.33) | 0.235(0.198,0.257) | 644.695(641.42,649.282) |
| **19** | 642.445(638.543,649.105) | 0.25(0.205,0.34) | 643.285(639.2,649.967) |
| **20** | 642.165(637.233,644.162) | 0.22(0.205,0.268) | 642.915(637.95,645.01) |
| **21** | 631.82(626.81,638.77) | 0.24(0.17,0.295) | 632.515(627.773,639.707) |
| **22** | 623.94(620.94,629.773) | 0.225(0.2,0.273) | 624.71(621.885,630.622) |
| **23** | 637.815(635.733,643.682) | 0.245(0.185,0.278) | 638.7(636.465,644.61) |
| **24** | 633.185(625.802,637.128) | 0.215(0.155,0.23) | 634.03(626.585,637.795) |
| **25** | 632.16(624.608,648.98) | 0.23(0.2,0.25) | 632.825(625.285,649.802) |
| **26** | 647.625(639.403,653.422) | 0.275(0.222,0.353) | 648.485(640.168,654.23) |
| **27** | 632.435(629.86,644.05) | 0.205(0.165,0.25) | 633.265(630.572,644.962) |
| **28** | 642.86(640.31,653.66) | 0.235(0.2,0.265) | 643.735(641.103,654.36) |
| **29** | 653.42(647.357,661.18) | 0.285(0.223,0.355) | 654.415(648.653,664.15) |
| **30** | 642.46(635.63,664.748) | 0.345(0.247,0.435) | 644.125(636.77,667.097) |
| **31** | 650.96(637.47,655.62) | 0.29(0.258,0.33) | 652.365(638.997,659.438) |
| **32** | 642.635(639.618,649.623) | 0.305(0.28,0.36) | 644.17(641.48,651.642) |

Table 23. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 1.068(1.03,1.283) | 6.5(4.25,8) | 1(1,2) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0) | 0(0,0) |
| **2** | 0.849(0.65,1.025) | 4(1.75,4.75) | 2.5(2,3) | 55(0.1,100) | 0.35(0.1,0.4) | 0(0,0) | 0(0,0) |
| **3** | 4.484(4.082,4.933) | 1(1,4) | 1(1,1) | 0.1(0.1,100) | 0.1(0.1,0.4) | 0(0,0) | 0(0,0) |
| **4** | 5.04(4.888,5.715) | 1(1,3.75) | 1(1,1) | 0.1(0.1,0.775) | 0.1(0.1,0.175) | 0(0,0) | 0(0,0) |
| **5** | 6.929(6.747,7.3) | 2.5(1,4) | 1(1,1.75) | 0.55(0.1,100) | 0.15(0.1,0.4) | 0(0,0) | 0(0,0) |
| **6** | 7.429(7.032,7.553) | 4(1,7.75) | 1(1,1) | 0.55(0.1,100) | 0.15(0.1,0.4) | 0(0,0.008) | 0(0,0) |
| **7** | 8.553(8.102,9.052) | 3(1,7) | 2(2,4.25) | 5.05(0.1,77.5) | 0.2(0.1,0.375) | 0(0,0) | 0(0,0) |
| **8** | 8.946(8.747,9.143) | 3(1.25,6.25) | 2(2,3.5) | 10(0.325,77.5) | 0.3(0.125,0.375) | 0(0,0) | 0(0,0) |
| **9** | 9.145(8.773,9.721) | 3(1,3) | 2(2,2) | 5.5(0.1,10) | 0.25(0.1,0.3) | 0(0,0) | 0(0,0) |
| **10** | 9.947(9.605,10.124) | 1(1,3.75) | 2(2,2) | 0.1(0.1,10) | 0.1(0.1,0.3) | 0(0,0) | 0(0,0) |
| **11** | 10.499(10.227,10.829) | 3(1.5,3) | 2(2,2) | 10(2.575,10) | 0.3(0.15,0.3) | 0(0,0) | 0(0,0.008) |
| **12** | 10.66(10.285,10.858) | 3(1.5,9.25) | 2(2,3.5) | 10(2.575,10) | 0.3(0.15,0.3) | 0(0,0.008) | 0(0,0.008) |
| **13** | 11.427(11.094,11.679) | 3(2,3.75) | 2(1,2.75) | 10(1,10) | 0.3(0.2,0.3) | 0(0,0) | 0(0,0) |
| **14** | 11.516(11.288,11.644) | 4(3.25,9.25) | 2.5(1.25,4.75) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0.008) | 0(0,0.01) |
| **15** | 12.527(11.905,12.637) | 2.5(2,3) | 2(1,2.75) | 5.5(1,10) | 0.25(0.2,0.3) | 0(0,0) | 0(0,0.008) |
| **16** | 12.613(12.313,12.709) | 4(3,4) | 1(1,5) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0) | 0(0,0.008) |
| **17** | 12.899(12.623,12.946) | 4(2.5,7) | 1(1,4) | 100(25.75,100) | 0.4(0.25,0.4) | 0(0,0) | 0(0,0.01) |
| **18** | 12.8(12.696,12.973) | 2.5(1,3) | 1.5(1,3.5) | 5.5(0.1,10) | 0.25(0.1,0.3) | 0(0,0) | 0.005(0,0.01) |
| **19** | 12.759(11.904,12.837) | 3.5(2,4) | 1.5(1,2) | 55(1,100) | 0.35(0.2,0.4) | 0(0,0) | 0(0,0) |
| **20** | 12.661(12.399,12.866) | 3(1.25,4) | 3(1.25,4.75) | 10(0.325,100) | 0.3(0.125,0.4) | 0(0,0) | 0.01(0,0.01) |
| **21** | 12.285(11.792,12.811) | 3(1,4) | 2.5(1.25,4) | 10(0.1,77.5) | 0.3(0.1,0.375) | 0(0,0) | 0(0,0.01) |
| **22** | 12.466(12.019,12.786) | 3(1,4) | 1(1,1.75) | 5.5(0.1,100) | 0.25(0.1,0.4) | 0(0,0) | 0(0,0) |
| **23** | 12.493(12.142,12.673) | 2.5(1,3) | 2(1,4.25) | 5.5(0.1,10) | 0.25(0.1,0.3) | 0(0,0) | 0(0,0.008) |
| **24** | 12.537(12.027,12.729) | 2(1,4) | 2.5(1.25,4.75) | 1(0.1,77.5) | 0.2(0.1,0.375) | 0(0,0) | 0.005(0,0.01) |
| **25** | 12.6(12.457,12.7) | 3(1.25,7) | 4.5(1.5,7.75) | 50.5(0.325,100) | 0.3(0.125,0.4) | 0(0,0) | 0.01(0,0.01) |
| **26** | 12.411(11.996,12.768) | 3.5(2,4) | 2.5(2,4.75) | 55(1,100) | 0.35(0.2,0.4) | 0(0,0) | 0.005(0,0.01) |
| **27** | 12.901(12.341,13.084) | 3(1,3.75) | 1(1,1) | 10(0.1,10) | 0.3(0.1,0.3) | 0(0,0) | 0(0,0) |
| **28** | 12.838(12.598,13.095) | 1.5(1,2.75) | 1.5(1,2.75) | 0.55(0.1,7.75) | 0.15(0.1,0.275) | 0(0,0) | 0.01(0,0.01) |
| **29** | 12.357(12.18,12.66) | 4(2.5,9.25) | 4(2,7.25) | 100(3.25,100) | 0.4(0.225,0.4) | 0(0,0.008) | 0.01(0,0.01) |
| **30** | 12.708(12.493,12.776) | 3(2.25,4) | 1(1,1.75) | 10(3.25,100) | 0.3(0.225,0.4) | 0(0,0) | 0(0,0) |
| **31** | 12.755(12.508,13.034) | 3.5(1,4) | 2(1,4.25) | 10(0.1,100) | 0.3(0.1,0.4) | 0(0,0) | 0.005(0,0.01) |
| **32** | 12.755(12.589,12.829) | 4(3,4) | 1.5(1,2) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0) | 0(0,0.008) |

Table 24. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

#### 2.2.3.2 Frontal Region (1)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 25)

The User, System and Elapsed Time group by number of HPCA (Table 26): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

The Model fitting parameters group by number of HPCA (Table 27): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | **MSPE** | | **Correlation** | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.004(0.001,0.01) | 0.216(0.184,0.217) | 0.998(0.995,1) | 0.89(0.889,0.907) |
| **2** | 0.001(0.001,0.002) | 0.032(0.031,0.04) | 0.999(0.999,0.999) | 0.984(0.98,0.985) |
| **3** | 0.056(0.047,0.114) | 0.34(0.323,0.475) | 0.971(0.941,0.976) | 0.814(0.736,0.824) |
| **4** | 0.053(0.051,0.053) | 0.33(0.292,0.442) | 0.973(0.973,0.974) | 0.821(0.749,0.843) |
| **5** | 0.161(0.161,0.228) | 0.616(0.581,0.619) | 0.916(0.878,0.916) | 0.629(0.627,0.655) |
| **6** | 0.182(0.182,0.182) | 0.685(0.611,0.787) | 0.904(0.904,0.904) | 0.584(0.522,0.63) |
| **7** | 0.138(0.096,0.15) | 0.567(0.567,0.706) | 0.928(0.922,0.951) | 0.662(0.573,0.662) |
| **8** | 0.146(0.146,0.159) | 0.645(0.645,0.645) | 0.924(0.917,0.924) | 0.61(0.61,0.61) |
| **9** | 0.211(0.202,0.338) | 0.667(0.63,0.667) | 0.888(0.812,0.893) | 0.593(0.593,0.608) |
| **10** | 0.299(0.212,0.372) | 0.656(0.642,0.679) | 0.836(0.792,0.888) | 0.587(0.582,0.615) |
| **11** | 0.429(0.353,0.433) | 0.742(0.726,0.935) | 0.77(0.752,0.836) | 0.524(0.292,0.527) |
| **12** | 0.445(0.445,0.455) | 0.757(0.705,0.883) | 0.745(0.738,0.745) | 0.5(0.357,0.544) |
| **13** | 0.478(0.428,0.531) | 0.734(0.71,0.764) | 0.722(0.684,0.756) | 0.523(0.491,0.541) |
| **14** | 0.488(0.346,0.494) | 0.772(0.699,0.87) | 0.715(0.711,0.812) | 0.492(0.406,0.548) |
| **15** | 0.352(0.326,0.556) | 0.91(0.731,0.914) | 0.82(0.665,0.837) | 0.314(0.309,0.522) |
| **16** | 0.439(0.346,0.572) | 0.932(0.748,0.984) | 0.754(0.654,0.823) | 0.287(0.152,0.507) |
| **17** | 0.55(0.387,0.573) | 0.851(0.745,1.124) | 0.67(0.653,0.796) | 0.437(0.157,0.511) |
| **18** | 0.399(0.318,0.556) | 0.917(0.761,0.953) | 0.787(0.665,0.841) | 0.304(0.278,0.496) |
| **19** | 0.344(0.318,0.393) | 0.964(0.837,1.032) | 0.82(0.792,0.839) | 0.252(0.189,0.419) |
| **20** | 0.574(0.424,0.574) | 0.734(0.734,0.77) | 0.653(0.653,0.767) | 0.519(0.489,0.519) |
| **21** | 0.403(0.338,0.515) | 0.936(0.802,1.039) | 0.786(0.696,0.829) | 0.299(0.183,0.467) |
| **22** | 0.36(0.307,0.403) | 1.069(0.86,1.126) | 0.814(0.785,0.848) | 0.203(0.125,0.406) |
| **23** | 0.326(0.318,0.395) | 0.944(0.814,0.956) | 0.828(0.791,0.841) | 0.32(0.247,0.462) |
| **24** | 0.394(0.337,0.543) | 0.861(0.755,1.016) | 0.792(0.675,0.822) | 0.382(0.222,0.499) |
| **25** | 0.447(0.319,0.575) | 0.779(0.733,0.938) | 0.746(0.651,0.84) | 0.485(0.279,0.519) |
| **26** | 0.47(0.379,0.575) | 0.835(0.734,1.003) | 0.734(0.652,0.801) | 0.4(0.232,0.519) |
| **27** | 0.359(0.319,0.574) | 0.853(0.742,0.94) | 0.814(0.652,0.84) | 0.39(0.277,0.513) |
| **28** | 0.32(0.3,0.574) | 0.84(0.731,1.01) | 0.832(0.652,0.853) | 0.404(0.288,0.522) |
| **29** | 0.34(0.319,0.39) | 0.94(0.929,1.042) | 0.827(0.794,0.841) | 0.277(0.207,0.289) |
| **30** | 0.478(0.32,0.574) | 0.859(0.741,0.964) | 0.725(0.652,0.84) | 0.384(0.249,0.514) |
| **31** | 0.382(0.322,0.575) | 0.946(0.735,1.049) | 0.799(0.652,0.839) | 0.27(0.184,0.517) |
| **32** | 0.533(0.387,0.575) | 0.759(0.73,0.951) | 0.682(0.652,0.796) | 0.501(0.264,0.522) |

Table 25. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for frontal region brain.

| HPCA | Time | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 178.2(176.198,178.673) | 0.205(0.103,0.31) | 178.96(176.903,179.585) |
| **2** | 172.78(169.893,174.69) | 0.155(0.13,0.373) | 173.415(170.365,175.325) |
| **3** | 256.885(255.465,259.752) | 0.105(0.085,0.145) | 257.36(255.873,260.332) |
| **4** | 270.125(267.97,277.557) | 0.18(0.145,0.238) | 270.665(268.538,278.173) |
| **5** | 360.8(357.987,366.925) | 0.15(0.105,0.172) | 361.645(358.403,367.573) |
| **6** | 369.625(368.962,370.37) | 0.145(0.13,0.197) | 370.465(369.29,370.875) |
| **7** | 454.82(450.585,457.79) | 0.185(0.162,0.243) | 455.295(452.023,458.378) |
| **8** | 459.14(455.607,461.945) | 0.205(0.19,0.267) | 459.74(456.27,462.54) |
| **9** | 538.2(531.705,540.475) | 0.175(0.153,0.198) | 538.855(532.462,541.078) |
| **10** | 540.785(534.775,547.628) | 0.24(0.192,0.363) | 541.605(535.383,548.17) |
| **11** | 539.565(534.088,544.357) | 0.22(0.192,0.227) | 540.75(535.675,545.232) |
| **12** | 548.82(542.112,552.207) | 0.21(0.148,0.238) | 550.07(542.968,553.99) |
| **13** | 596.305(588.862,600.14) | 0.265(0.208,0.287) | 597.375(589.963,601.415) |
| **14** | 597.82(587.975,603.365) | 0.26(0.21,0.295) | 599.59(589.215,604.343) |
| **15** | 627.21(614.983,633.135) | 0.28(0.22,0.337) | 627.93(615.8,634.005) |
| **16** | 625.915(620.675,632.87) | 0.17(0.14,0.257) | 626.57(621.217,633.425) |
| **17** | 629.29(622.51,641.743) | 0.255(0.185,0.333) | 629.945(623.393,642.335) |
| **18** | 621.12(616.36,624.86) | 0.265(0.192,0.345) | 621.98(617.175,625.568) |
| **19** | 625.195(622.09,629.285) | 0.175(0.14,0.212) | 625.875(622.772,629.96) |
| **20** | 624.62(618.335,626.585) | 0.245(0.192,0.267) | 625.36(619.145,627.563) |
| **21** | 625.935(619.432,629.405) | 0.205(0.17,0.22) | 626.53(620.058,629.975) |
| **22** | 626.035(617.165,630.485) | 0.22(0.2,0.258) | 626.675(617.952,631.012) |
| **23** | 630.25(617.063,635.045) | 0.19(0.155,0.273) | 630.925(617.753,635.683) |
| **24** | 623.45(615.427,631.3) | 0.22(0.173,0.243) | 624.05(616.072,632.235) |
| **25** | 618.875(611.662,629.035) | 0.225(0.177,0.323) | 619.785(612.482,629.59) |
| **26** | 625.885(614.997,632.513) | 0.22(0.2,0.243) | 626.545(615.685,633.387) |
| **27** | 628.15(618.432,634.38) | 0.245(0.205,0.285) | 628.965(619.19,635.115) |
| **28** | 632.455(620.033,636.963) | 0.25(0.203,0.293) | 633.29(620.968,637.69) |
| **29** | 627.1(617.632,633.415) | 0.24(0.212,0.325) | 627.995(618.383,634.238) |
| **30** | 626.73(622.495,634.482) | 0.295(0.28,0.35) | 627.645(623.48,635.4) |
| **31** | 627.095(624.605,631.555) | 0.225(0.19,0.322) | 627.89(625.383,632.597) |
| **32** | 617.385(611.248,624.925) | 0.225(0.22,0.273) | 618.28(612.065,626.782) |

Table 26. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 0.97(0.791,1.029) | 8(5.75,8) | 2.5(1.25,5.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **2** | 0.667(0.635,0.728) | 3(3,3.75) | 2.5(2,4) | 10(10,77.5) | 0.3(0.3,0.375) | 0(0,0) | 0(0,0) |
| **3** | 4.085(3.997,4.481) | 3.5(1.5,4) | 1(1,1) | 55(2.575,100) | 0.35(0.15,0.4) | 0(0,0) | 0(0,0) |
| **4** | 5.481(4.958,5.96) | 4(1,9) | 1(1,2.5) | 0.1(0.1,7.75) | 0.1(0.1,0.275) | 0(0,0.01) | 0(0,0) |
| **5** | 6.69(6.482,7.293) | 3(1.25,4) | 1(1,1) | 0.55(0.1,75.25) | 0.15(0.1,0.35) | 0(0,0) | 0(0,0) |
| **6** | 7.082(6.6,7.413) | 3.5(1,9) | 1(1,1) | 0.1(0.1,1) | 0.1(0.1,0.2) | 0(0,0.01) | 0(0,0) |
| **7** | 8.2(7.749,8.511) | 1(1,3) | 2(2,2.75) | 0.1(0.1,10) | 0.1(0.1,0.3) | 0(0,0) | 0(0,0) |
| **8** | 8.683(8.284,8.932) | 1(1,1.75) | 2(2,2) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **9** | 9.686(9.345,10.16) | 1(1,2.75) | 2(1.25,2) | 0.1(0.1,0.775) | 0.1(0.1,0.175) | 0(0,0) | 0(0,0) |
| **10** | 9.718(9.549,9.995) | 1(1,3) | 1.5(1,2) | 0.1(0.1,10) | 0.1(0.1,0.3) | 0(0,0) | 0(0,0) |
| **11** | 11.155(10.992,11.353) | 1(1,1) | 1.5(1,4.25) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0.008) |
| **12** | 11.092(10.721,11.517) | 2(1,3) | 1(1,1) | 0.1(0.1,10) | 0.1(0.1,0.3) | 0(0,0) | 0(0,0) |
| **13** | 11.52(11.235,11.955) | 4(3,4) | 1(1,1.75) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0) | 0(0,0) |
| **14** | 12.076(11.939,12.156) | 3(1.5,3) | 1(1,2.75) | 10(2.575,10) | 0.3(0.15,0.3) | 0(0,0) | 0(0,0) |
| **15** | 12.793(12.221,13.344) | 2(1,3.75) | 4(1,5) | 5.05(0.1,77.5) | 0.2(0.1,0.375) | 0(0,0) | 0.01(0,0.01) |
| **16** | 12.42(12.249,13.363) | 2.5(1,4) | 4.5(1,5.75) | 5.05(0.1,100) | 0.2(0.1,0.4) | 0(0,0) | 0.01(0,0.01) |
| **17** | 12.108(11.381,12.545) | 4(4,11.75) | 1(1,6.5) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.01) | 0(0,0.01) |
| **18** | 12.271(11.794,12.662) | 3.5(1,4) | 4(1,5) | 55(0.1,100) | 0.35(0.1,0.4) | 0(0,0) | 0.005(0,0.01) |
| **19** | 12.119(11.969,12.406) | 3.5(1,4) | 5(2.75,5.75) | 55(0.1,100) | 0.35(0.1,0.4) | 0(0,0) | 0.01(0.003,0.01) |
| **20** | 12.907(12.488,13.128) | 4(4,4) | 1(1,2.5) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **21** | 12.375(11.957,12.644) | 5.5(1.75,8) | 4.5(1,5) | 55(2.575,100) | 0.35(0.15,0.4) | 0(0,0) | 0.005(0,0.01) |
| **22** | 12.103(11.374,12.573) | 6(4,11.75) | 5.5(3.5,6) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0.01) | 0.01(0,0.01) |
| **23** | 12.54(12.245,12.898) | 3(1,9.25) | 4(2.25,5) | 5.5(0.1,77.5) | 0.25(0.1,0.375) | 0(0,0.008) | 0.005(0,0.01) |
| **24** | 12.126(11.979,12.277) | 4(1.5,4) | 3(1.25,5) | 100(2.575,100) | 0.4(0.15,0.4) | 0(0,0) | 0.005(0,0.01) |
| **25** | 12.533(12.308,13.031) | 2.5(1,4) | 2(1,5) | 50.05(0.1,100) | 0.25(0.1,0.4) | 0(0,0) | 0(0,0.01) |
| **26** | 12.497(12.371,12.829) | 4(2.25,7) | 2.5(1,5) | 100(3.25,100) | 0.4(0.225,0.4) | 0(0,0) | 0.005(0,0.01) |
| **27** | 12.713(12.599,12.976) | 4(1.25,4) | 3.5(1,5) | 55(0.325,100) | 0.35(0.125,0.4) | 0(0,0) | 0.005(0,0.01) |
| **28** | 12.528(12.439,12.585) | 4(1.75,4) | 3.5(1,5.75) | 100(2.575,100) | 0.4(0.15,0.4) | 0(0,0) | 0(0,0.008) |
| **29** | 12.571(12.112,12.838) | 1(1,4) | 5(4.25,5.75) | 0.1(0.1,100) | 0.1(0.1,0.4) | 0(0,0) | 0.01(0.01,0.01) |
| **30** | 12.723(12.058,13.143) | 4(1.75,4) | 3(1,5) | 100(25.075,100) | 0.4(0.175,0.4) | 0(0,0) | 0.005(0,0.01) |
| **31** | 12.556(12.436,12.7) | 4(1.5,7) | 5(1,5) | 100(2.575,100) | 0.4(0.15,0.4) | 0(0,0) | 0.01(0,0.01) |
| **32** | 12.699(12.173,13.067) | 4(1.75,4) | 1(1,5) | 100(25.075,100) | 0.4(0.175,0.4) | 0(0,0) | 0(0,0.01) |

Table 27. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

#### 2.2.3.3 Central Region (2)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 28)

The User, System and Elapsed Time group by number of HPCA (Table 29): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 30): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.012(0.002,0.016) | 0.221(0.165,0.235) | 0.994(0.992,0.999) | 0.885(0.877,0.916) |
| **2** | 0.002(0.001,0.009) | 0.136(0.126,0.146) | 0.999(0.996,1) | 0.929(0.924,0.935) |
| **3** | 0.06(0.037,0.081) | 0.466(0.4,0.533) | 0.97(0.959,0.982) | 0.74(0.694,0.782) |
| **4** | 0.059(0.053,0.065) | 0.446(0.386,0.506) | 0.97(0.967,0.973) | 0.748(0.707,0.784) |
| **5** | 0.262(0.206,0.262) | 0.656(0.656,0.656) | 0.859(0.859,0.891) | 0.606(0.606,0.606) |
| **6** | 0.263(0.263,0.263) | 0.639(0.639,0.639) | 0.859(0.859,0.859) | 0.616(0.616,0.616) |
| **7** | 0.138(0.138,0.138) | 0.645(0.639,0.658) | 0.928(0.928,0.928) | 0.629(0.619,0.631) |
| **8** | 0.145(0.142,0.15) | 0.664(0.624,0.691) | 0.924(0.922,0.926) | 0.618(0.595,0.637) |
| **9** | 0.25(0.21,0.364) | 0.69(0.666,0.713) | 0.866(0.798,0.889) | 0.6(0.578,0.622) |
| **10** | 0.396(0.21,0.423) | 0.733(0.683,0.769) | 0.798(0.778,0.889) | 0.555(0.5,0.6) |
| **11** | 0.4(0.253,0.445) | 0.83(0.774,0.92) | 0.785(0.764,0.864) | 0.465(0.371,0.541) |
| **12** | 0.386(0.28,0.444) | 0.776(0.754,0.853) | 0.804(0.758,0.853) | 0.503(0.418,0.549) |
| **13** | 0.459(0.384,0.471) | 0.815(0.79,0.903) | 0.735(0.727,0.796) | 0.485(0.37,0.51) |
| **14** | 0.464(0.384,0.516) | 0.812(0.763,0.893) | 0.736(0.696,0.796) | 0.49(0.372,0.527) |
| **15** | 0.502(0.416,0.562) | 0.814(0.756,0.863) | 0.705(0.661,0.777) | 0.466(0.39,0.514) |
| **16** | 0.538(0.429,0.586) | 0.818(0.738,0.899) | 0.687(0.643,0.758) | 0.459(0.376,0.536) |
| **17** | 0.541(0.495,0.58) | 0.835(0.756,0.892) | 0.676(0.648,0.71) | 0.444(0.393,0.513) |
| **18** | 0.494(0.353,0.603) | 0.912(0.879,0.979) | 0.725(0.638,0.818) | 0.335(0.318,0.363) |
| **19** | 0.509(0.416,0.621) | 0.896(0.87,0.909) | 0.71(0.623,0.776) | 0.365(0.36,0.393) |
| **20** | 0.545(0.496,0.612) | 0.824(0.791,0.903) | 0.677(0.629,0.712) | 0.444(0.343,0.467) |
| **21** | 0.584(0.495,0.621) | 0.824(0.754,0.86) | 0.644(0.623,0.71) | 0.456(0.377,0.503) |
| **22** | 0.503(0.392,0.579) | 0.808(0.735,0.944) | 0.711(0.648,0.79) | 0.443(0.302,0.539) |
| **23** | 0.43(0.31,0.558) | 0.867(0.809,0.928) | 0.76(0.676,0.846) | 0.376(0.329,0.456) |
| **24** | 0.497(0.349,0.562) | 0.869(0.752,0.932) | 0.709(0.661,0.821) | 0.449(0.334,0.515) |
| **25** | 0.543(0.441,0.639) | 0.862(0.815,0.873) | 0.675(0.614,0.755) | 0.391(0.376,0.45) |
| **26** | 0.425(0.369,0.544) | 0.896(0.72,0.981) | 0.763(0.674,0.808) | 0.364(0.308,0.55) |
| **27** | 0.518(0.5,0.609) | 0.863(0.806,0.909) | 0.694(0.63,0.711) | 0.404(0.342,0.455) |
| **28** | 0.586(0.516,0.634) | 0.827(0.754,0.846) | 0.643(0.618,0.695) | 0.44(0.416,0.502) |
| **29** | 0.581(0.428,0.644) | 0.862(0.817,0.94) | 0.661(0.611,0.767) | 0.378(0.326,0.439) |
| **30** | 0.555(0.496,0.635) | 0.899(0.846,0.929) | 0.673(0.616,0.719) | 0.362(0.342,0.4) |
| **31** | 0.587(0.498,0.647) | 0.856(0.807,0.87) | 0.65(0.609,0.708) | 0.403(0.375,0.458) |
| **32** | 0.502(0.355,0.562) | 0.9(0.844,0.925) | 0.708(0.675,0.817) | 0.356(0.332,0.441) |

Table 28. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for central region of the brain.

| HPCA | Time | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 191.625(189.765,193.765) | 0.11(0.095,0.143) | 192.17(190.075,194.162) |
| **2** | 186.92(184.365,188.205) | 0.105(0.09,0.16) | 187.26(184.72,188.573) |
| **3** | 261.955(259.61,264.145) | 0.095(0.082,0.12) | 262.44(259.97,264.582) |
| **4** | 269.97(268.013,272.723) | 0.115(0.093,0.188) | 270.475(268.373,273.14) |
| **5** | 358.79(353.998,366.905) | 0.165(0.132,0.19) | 359.39(354.515,368.33) |
| **6** | 360.3(356.403,365.733) | 0.14(0.118,0.2) | 360.8(358.752,366.21) |
| **7** | 451.085(443.948,455) | 0.185(0.162,0.257) | 451.995(444.622,455.853) |
| **8** | 449.625(443.995,455.312) | 0.185(0.148,0.235) | 450.365(445.015,456.13) |
| **9** | 544.545(537.902,558.155) | 0.2(0.158,0.255) | 545.17(538.638,558.952) |
| **10** | 542.55(539.722,546.735) | 0.21(0.192,0.237) | 543.3(540.74,547.525) |
| **11** | 535.185(531.37,542.455) | 0.22(0.192,0.273) | 536(531.997,543.437) |
| **12** | 540.28(531.577,546.755) | 0.225(0.173,0.273) | 541.05(532.725,547.515) |
| **13** | 591.565(575.998,599.887) | 0.22(0.197,0.262) | 592.495(576.775,600.855) |
| **14** | 579.385(574.537,583.605) | 0.2(0.18,0.228) | 580.055(575.317,584.375) |
| **15** | 646.53(636.348,675.118) | 0.325(0.227,0.455) | 647.295(637.765,717.863) |
| **16** | 649.47(641.218,673.715) | 0.31(0.235,0.35) | 651.555(642.777,675.642) |
| **17** | 647.685(641.085,652.395) | 0.315(0.285,0.33) | 649.6(643.242,654.713) |
| **18** | 655.995(641.885,666.055) | 0.4(0.265,0.443) | 657.735(644.205,668.588) |
| **19** | 635.955(621.17,645.705) | 0.225(0.175,0.295) | 637.525(622.122,646.398) |
| **20** | 625.475(614.745,629.478) | 0.23(0.19,0.303) | 626.515(615.825,630.46) |
| **21** | 624.765(614.887,639.603) | 0.26(0.203,0.315) | 626.57(615.86,640.828) |
| **22** | 627.415(615.98,634.055) | 0.285(0.263,0.34) | 628.47(617.645,635.085) |
| **23** | 578.88(549.797,631.913) | 0.185(0.155,0.332) | 582.915(550.787,632.72) |
| **24** | 538.035(525.488,608.597) | 0.215(0.16,0.257) | 538.68(526.16,614.497) |
| **25** | 540.23(526.32,550.383) | 0.195(0.16,0.228) | 540.79(526.707,551.265) |
| **26** | 528.695(522.322,535.735) | 0.225(0.175,0.273) | 529.17(522.773,536.258) |
| **27** | 533.99(529.04,537.028) | 0.2(0.165,0.22) | 534.535(529.513,537.46) |
| **28** | 533.165(529.427,539.49) | 0.155(0.115,0.225) | 533.605(529.913,540.048) |
| **29** | 533.92(530.8,535.54) | 0.18(0.15,0.218) | 534.4(531.388,535.982) |
| **30** | 532.51(525.675,536.183) | 0.21(0.178,0.243) | 532.875(526.13,536.737) |
| **31** | 528.555(518.625,537.218) | 0.195(0.175,0.302) | 529.17(519.14,537.86) |
| **32** | 538.885(532.288,546.8) | 0.19(0.145,0.258) | 539.5(532.828,547.45) |

Table 29. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for central region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 1.364(1.283,1.62) | 6(4,8) | 2.5(2,5.5) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **2** | 1.071(0.936,1.452) | 4(4,6.25) | 4(2,4) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0) | 0(0,0) |
| **3** | 5.06(4.721,5.552) | 3.5(1,4) | 2(1,2.75) | 55(0.1,100) | 0.35(0.1,0.4) | 0(0,0) | 0(0,0) |
| **4** | 5.348(4.541,6.229) | 3(1.25,3) | 1(1,1) | 5.5(0.1,10) | 0.25(0.1,0.3) | 0(0,0) | 0(0,0) |
| **5** | 7.238(6.792,7.751) | 4(4,4) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **6** | 7.003(6.676,7.411) | 4(4,4) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **7** | 8.178(7.705,8.556) | 3(3,3.75) | 2(2,2) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0(0,0) |
| **8** | 8.275(7.88,9.019) | 4(3,6.25) | 2(2,2) | 10(10,77.5) | 0.3(0.3,0.375) | 0(0,0) | 0(0,0) |
| **9** | 9.921(9.187,10.366) | 3(3,4) | 2(2,2) | 10(10,77.5) | 0.3(0.3,0.375) | 0(0,0) | 0(0,0) |
| **10** | 10.015(9.841,10.118) | 3.5(3,6.25) | 2(2,2) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0(0,0.01) |
| **11** | 10.314(10.012,10.723) | 3.5(3,5.75) | 2(2,2) | 10(3.25,10) | 0.3(0.225,0.3) | 0(0,0) | 0.005(0,0.01) |
| **12** | 10.482(10.123,10.894) | 3(3,3) | 2(2,2.75) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0.005(0,0.01) |
| **13** | 11.425(11.119,11.709) | 5.5(3,7) | 1(1,2.5) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0(0,0.01) |
| **14** | 11.242(11.101,11.812) | 4(1.5,7) | 1(1,2.75) | 10(2.575,77.5) | 0.3(0.15,0.375) | 0(0,0) | 0(0,0.01) |
| **15** | 12.33(12.168,12.717) | 2.5(1,3.75) | 1(1,2) | 5.5(0.1,10) | 0.25(0.1,0.3) | 0(0,0) | 0(0,0.01) |
| **16** | 12.323(12.233,12.847) | 4(3.25,8) | 1.5(1,2) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0) | 0.005(0,0.01) |
| **17** | 12.635(12.543,12.904) | 3.5(2,4) | 1(1,1) | 55(1,100) | 0.35(0.2,0.4) | 0(0,0) | 0(0,0.01) |
| **18** | 12.45(12.216,12.614) | 2(1,3.75) | 2.5(1,4.75) | 1(0.1,77.5) | 0.2(0.1,0.375) | 0(0,0) | 0.01(0.01,0.01) |
| **19** | 12.386(11.975,12.67) | 2(1.25,3) | 1.5(1,2.75) | 1(0.325,10) | 0.2(0.125,0.3) | 0(0,0) | 0.01(0.01,0.01) |
| **20** | 12.494(12.298,12.816) | 3.5(1.25,4) | 1(1,2.5) | 10(0.325,100) | 0.3(0.125,0.4) | 0(0,0) | 0.01(0,0.01) |
| **21** | 12.633(12.147,12.716) | 3(1,7) | 1(1,1) | 50.5(0.1,100) | 0.3(0.1,0.4) | 0(0,0) | 0.005(0,0.01) |
| **22** | 12.34(12.077,12.546) | 4(2.5,9.25) | 1.5(1,5) | 100(3.25,100) | 0.4(0.225,0.4) | 0(0,0.008) | 0.005(0,0.01) |
| **23** | 12.312(12.088,12.658) | 2.5(1,4) | 3.5(1,5) | 5.5(0.1,100) | 0.25(0.1,0.4) | 0(0,0) | 0.01(0.01,0.01) |
| **24** | 12.155(11.872,12.653) | 3.5(2.25,4) | 1(1,5.25) | 55(3.25,100) | 0.35(0.225,0.4) | 0(0,0) | 0(0,0.01) |
| **25** | 12.277(12.012,12.368) | 1.5(1,3.75) | 1(1,2.5) | 0.55(0.1,77.5) | 0.15(0.1,0.375) | 0(0,0) | 0.01(0.003,0.01) |
| **26** | 12.374(12.226,12.757) | 4(4,10) | 3(1.25,5.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.008) | 0.01(0,0.01) |
| **27** | 12.251(12.142,12.42) | 3.5(2,6.25) | 1(1,1) | 10(1,77.5) | 0.3(0.2,0.375) | 0(0,0) | 0.005(0,0.01) |
| **28** | 12.307(11.997,12.558) | 4(3.25,8) | 1(1,1.75) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0) | 0.01(0,0.01) |
| **29** | 12.494(12.338,12.55) | 4(2.25,7.25) | 2(1,4.25) | 55(0.325,100) | 0.35(0.125,0.4) | 0(0,0) | 0.01(0.01,0.01) |
| **30** | 12.405(12.151,12.748) | 3.5(1.25,7.75) | 1(1,2) | 10(0.325,77.5) | 0.3(0.125,0.375) | 0(0,0) | 0.01(0.01,0.01) |
| **31** | 12.548(12.434,12.978) | 1.5(1,6.75) | 1(1,1) | 0.55(0.1,77.5) | 0.15(0.1,0.375) | 0(0,0) | 0.01(0,0.01) |
| **32** | 12.307(12.079,12.604) | 2.5(1,6.25) | 2(1,4.5) | 5.5(0.1,10) | 0.25(0.1,0.3) | 0(0,0) | 0.01(0.01,0.01) |

Table 30. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for central region of the brain.

#### 2.2.3.4 Occipital Region (3)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 31)

The User, System and Elapsed Time group by number of HPCA (Table 32): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 33): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0(0,0) | 0.003(0.002,0.003) | 1(1,1) | 0.999(0.998,0.999) |
| **2** | 0.008(0.006,0.008) | 0.104(0.104,0.162) | 0.996(0.996,0.997) | 0.947(0.918,0.947) |
| **3** | 0.036(0.034,0.039) | 0.091(0.088,0.091) | 0.982(0.98,0.983) | 0.955(0.954,0.956) |
| **4** | 0.063(0.063,0.063) | 0.119(0.119,0.119) | 0.968(0.968,0.968) | 0.939(0.939,0.939) |
| **5** | 0.064(0.064,0.064) | 0.106(0.106,0.106) | 0.967(0.967,0.967) | 0.946(0.946,0.946) |
| **6** | 0.08(0.08,0.08) | 0.22(0.22,0.22) | 0.959(0.959,0.959) | 0.887(0.887,0.887) |
| **7** | 0.087(0.087,0.087) | 0.223(0.223,0.223) | 0.956(0.956,0.956) | 0.885(0.885,0.885) |
| **8** | 0.097(0.097,0.097) | 0.244(0.244,0.244) | 0.95(0.95,0.95) | 0.873(0.873,0.873) |
| **9** | 0.1(0.1,0.1) | 0.246(0.246,0.246) | 0.949(0.949,0.949) | 0.872(0.872,0.872) |
| **10** | 0.115(0.115,0.115) | 0.293(0.293,0.293) | 0.941(0.941,0.941) | 0.846(0.846,0.846) |
| **11** | 0.117(0.117,0.117) | 0.291(0.291,0.291) | 0.939(0.939,0.939) | 0.847(0.847,0.847) |
| **12** | 0.139(0.134,0.139) | 0.299(0.299,0.302) | 0.928(0.928,0.93) | 0.839(0.837,0.839) |
| **13** | 0.14(0.14,0.14) | 0.301(0.301,0.301) | 0.927(0.927,0.927) | 0.838(0.838,0.838) |
| **14** | 0.152(0.131,0.152) | 0.309(0.309,0.348) | 0.921(0.921,0.932) | 0.833(0.811,0.833) |
| **15** | 0.154(0.15,0.154) | 0.31(0.31,0.312) | 0.92(0.92,0.922) | 0.832(0.831,0.832) |
| **16** | 0.156(0.152,0.156) | 0.321(0.321,0.323) | 0.919(0.919,0.921) | 0.826(0.825,0.826) |
| **17** | 0.156(0.156,0.156) | 0.321(0.321,0.321) | 0.919(0.919,0.919) | 0.826(0.826,0.826) |
| **18** | 0.156(0.128,0.156) | 0.321(0.321,0.373) | 0.919(0.919,0.934) | 0.826(0.796,0.826) |
| **19** | 0.153(0.128,0.156) | 0.322(0.321,0.372) | 0.92(0.919,0.934) | 0.825(0.796,0.826) |
| **20** | 0.156(0.134,0.156) | 0.322(0.322,0.36) | 0.919(0.919,0.931) | 0.825(0.803,0.825) |
| **21** | 0.15(0.15,0.156) | 0.323(0.321,0.323) | 0.922(0.919,0.922) | 0.825(0.825,0.826) |
| **22** | 0.14(0.129,0.157) | 0.348(0.323,0.372) | 0.927(0.918,0.933) | 0.81(0.796,0.825) |
| **23** | 0.157(0.135,0.157) | 0.322(0.322,0.36) | 0.918(0.918,0.93) | 0.825(0.803,0.825) |
| **24** | 0.157(0.153,0.157) | 0.321(0.321,0.321) | 0.918(0.918,0.92) | 0.825(0.825,0.825) |
| **25** | 0.143(0.129,0.157) | 0.334(0.321,0.371) | 0.926(0.918,0.933) | 0.818(0.797,0.825) |
| **26** | 0.128(0.128,0.145) | 0.343(0.318,0.369) | 0.933(0.924,0.934) | 0.812(0.798,0.827) |
| **27** | 0.154(0.129,0.156) | 0.318(0.318,0.368) | 0.92(0.918,0.933) | 0.827(0.798,0.828) |
| **28** | 0.151(0.129,0.157) | 0.321(0.319,0.37) | 0.921(0.918,0.933) | 0.826(0.798,0.827) |
| **29** | 0.151(0.129,0.157) | 0.321(0.319,0.37) | 0.921(0.918,0.933) | 0.826(0.797,0.827) |
| **30** | 0.14(0.129,0.152) | 0.345(0.32,0.369) | 0.927(0.921,0.933) | 0.812(0.798,0.826) |
| **31** | 0.151(0.151,0.157) | 0.321(0.319,0.321) | 0.921(0.918,0.921) | 0.826(0.826,0.827) |
| **32** | 0.157(0.153,0.157) | 0.319(0.319,0.32) | 0.918(0.918,0.92) | 0.827(0.826,0.827) |

Table 31. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Time | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 108.61(107.415,110.81) | 0.105(0.083,0.203) | 108.9(107.507,111.078) |
| **2** | 101.2(99.818,101.99) | 0.09(0.07,0.135) | 101.335(99.982,102.105) |
| **3** | 187.765(183.86,192.588) | 0.11(0.085,0.127) | 188.08(184.07,192.763) |
| **4** | 227.925(225.902,232.53) | 0.08(0.06,0.143) | 228.12(226.182,232.875) |
| **5** | 269.32(264.643,273.21) | 0.11(0.083,0.163) | 269.525(264.968,273.545) |
| **6** | 270.915(265.475,274.773) | 0.1(0.08,0.11) | 271.155(265.677,275.023) |
| **7** | 331.53(328.902,337.395) | 0.15(0.107,0.178) | 331.975(329.447,337.678) |
| **8** | 335.26(331.858,336.467) | 0.125(0.11,0.177) | 335.665(332.243,337.22) |
| **9** | 335.4(331.127,337.365) | 0.105(0.09,0.11) | 335.67(331.51,337.662) |
| **10** | 374.23(368.783,377.138) | 0.14(0.068,0.163) | 375.14(369.333,377.713) |
| **11** | 386.7(383.84,395.887) | 0.145(0.095,0.19) | 387.055(384.177,396.203) |
| **12** | 344.24(341.238,346.708) | 0.14(0.095,0.198) | 344.545(341.528,346.947) |
| **13** | 370.135(363.87,381.71) | 0.17(0.142,0.177) | 370.565(364.2,382.045) |
| **14** | 406.85(403.395,414.202) | 0.12(0.102,0.165) | 407.265(403.78,414.508) |
| **15** | 431.905(427.718,439.005) | 0.16(0.118,0.185) | 432.51(428.087,439.425) |
| **16** | 456.215(445.132,457.37) | 0.15(0.123,0.188) | 456.625(445.598,457.91) |
| **17** | 458.095(448.173,461.62) | 0.15(0.132,0.188) | 458.7(448.553,461.985) |
| **18** | 450.675(447.675,456.202) | 0.17(0.162,0.19) | 451.055(448.157,456.652) |
| **19** | 455.445(454.062,459.948) | 0.21(0.143,0.238) | 455.95(454.31,460.31) |
| **20** | 451.89(447.278,460.168) | 0.185(0.147,0.2) | 452.48(447.918,460.67) |
| **21** | 454.2(447.37,458.56) | 0.16(0.093,0.225) | 454.545(447.787,459.295) |
| **22** | 450.53(447.452,457.253) | 0.17(0.14,0.208) | 450.99(447.983,457.585) |
| **23** | 453.42(446.497,457.823) | 0.15(0.115,0.218) | 453.86(446.84,458.268) |
| **24** | 451.15(450.065,455.895) | 0.125(0.093,0.195) | 451.53(450.477,456.51) |
| **25** | 454.595(444.477,461.317) | 0.165(0.133,0.17) | 455(444.935,461.65) |
| **26** | 458.385(453.415,461.715) | 0.165(0.145,0.185) | 458.765(453.815,462.208) |
| **27** | 454.995(450.182,459.613) | 0.215(0.173,0.235) | 455.37(450.818,460.055) |
| **28** | 452.325(450.755,458.182) | 0.18(0.153,0.215) | 452.845(451.283,458.63) |
| **29** | 455.895(450.095,459.145) | 0.2(0.153,0.317) | 456.27(450.515,459.91) |
| **30** | 453.29(447.945,454.907) | 0.165(0.135,0.178) | 453.66(448.522,455.335) |
| **31** | 453.225(446.313,461.353) | 0.13(0.098,0.162) | 453.6(446.71,461.765) |
| **32** | 447.905(444.095,459.76) | 0.235(0.16,0.257) | 448.29(444.527,460.4) |

Table 32. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 0.025(0.023,0.029) | 5.5(4,8) | 2(2,3.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **2** | 0.36(0.319,0.404) | 4(4,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.01) | 0(0,0) |
| **3** | 1.227(1.164,1.281) | 9.5(8,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **4** | 1.83(1.706,1.882) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **5** | 1.856(1.784,2.145) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **6** | 2.122(2.073,2.186) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **7** | 2.343(2.217,2.471) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **8** | 2.603(2.465,2.647) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **9** | 2.581(2.428,2.744) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **10** | 2.855(2.763,2.932) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **11** | 2.902(2.779,3.015) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **12** | 3.704(3.481,4.033) | 12(5.75,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **13** | 3.644(3.566,3.672) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **14** | 3.958(3.761,4.066) | 12(11,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **15** | 3.726(3.593,3.871) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **16** | 3.83(3.736,3.953) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **17** | 3.714(3.639,3.85) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **18** | 3.638(3.53,3.767) | 12(11,12) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **19** | 3.637(3.517,3.719) | 11.5(11,12) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **20** | 3.761(3.719,3.971) | 12(11,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **21** | 4.056(3.77,4.288) | 8(4,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **22** | 3.639(3.518,3.826) | 11(11,12) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **23** | 3.798(3.709,3.87) | 12(11,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **24** | 3.781(3.539,3.929) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **25** | 3.83(3.655,4.035) | 12(11,12) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **26** | 3.856(3.758,4.229) | 11.5(11,12) | 1(1,1.75) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **27** | 3.677(3.536,4.206) | 11.5(11,12) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **28** | 3.865(3.649,3.963) | 11(11,12) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **29** | 3.848(3.548,4.11) | 11(11,12) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **30** | 3.847(3.645,3.937) | 11(4,11) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0,0.01) | 0(0,0) |
| **31** | 3.773(3.727,3.941) | 7.5(4,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **32** | 3.748(3.723,3.954) | 12(6,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0(0,0) |

Table 33. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

#### 2.2.3.5 Parietal (4)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 34)

The User, System and Elapsed Time group by number of HPCA (Table 35): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 36): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.007(0.002,0.017) | 0.134(0.127,0.155) | 0.996(0.991,0.999) | 0.931(0.921,0.935) |
| **2** | 0.009(0.009,0.009) | 0.102(0.102,0.153) | 0.995(0.995,0.995) | 0.948(0.921,0.948) |
| **3** | 0.08(0.047,0.092) | 0.414(0.384,0.415) | 0.959(0.953,0.976) | 0.775(0.775,0.794) |
| **4** | 0.077(0.053,0.091) | 0.403(0.403,0.408) | 0.961(0.953,0.973) | 0.782(0.782,0.782) |
| **5** | 0.191(0.145,0.191) | 0.59(0.59,0.607) | 0.899(0.899,0.925) | 0.662(0.658,0.662) |
| **6** | 0.196(0.192,0.196) | 0.594(0.594,0.594) | 0.896(0.896,0.899) | 0.66(0.66,0.66) |
| **7** | 0.115(0.11,0.152) | 0.596(0.569,0.627) | 0.941(0.921,0.943) | 0.672(0.663,0.684) |
| **8** | 0.137(0.109,0.283) | 0.591(0.567,0.62) | 0.929(0.846,0.944) | 0.674(0.665,0.685) |
| **9** | 0.191(0.164,0.287) | 0.569(0.566,0.595) | 0.899(0.844,0.914) | 0.681(0.673,0.687) |
| **10** | 0.301(0.17,0.311) | 0.583(0.572,0.594) | 0.84(0.83,0.911) | 0.668(0.66,0.677) |
| **11** | 0.311(0.202,0.371) | 0.705(0.684,0.716) | 0.83(0.793,0.896) | 0.608(0.607,0.613) |
| **12** | 0.317(0.212,0.322) | 0.686(0.685,0.73) | 0.826(0.823,0.887) | 0.61(0.603,0.619) |
| **13** | 0.332(0.277,0.337) | 0.805(0.785,0.821) | 0.817(0.814,0.858) | 0.533(0.523,0.555) |
| **14** | 0.335(0.332,0.352) | 0.796(0.748,0.807) | 0.815(0.805,0.817) | 0.543(0.532,0.567) |
| **15** | 0.389(0.376,0.438) | 0.775(0.746,0.784) | 0.782(0.749,0.79) | 0.557(0.524,0.574) |
| **16** | 0.374(0.373,0.395) | 0.765(0.689,0.785) | 0.791(0.778,0.791) | 0.556(0.538,0.578) |
| **17** | 0.388(0.373,0.46) | 0.783(0.686,0.812) | 0.782(0.734,0.791) | 0.547(0.52,0.606) |
| **18** | 0.389(0.375,0.394) | 0.773(0.746,0.784) | 0.782(0.778,0.79) | 0.566(0.542,0.573) |
| **19** | 0.393(0.376,0.395) | 0.773(0.746,0.786) | 0.779(0.777,0.789) | 0.561(0.537,0.574) |
| **20** | 0.395(0.374,0.438) | 0.765(0.746,0.787) | 0.777(0.749,0.791) | 0.555(0.537,0.574) |
| **21** | 0.384(0.373,0.395) | 0.766(0.745,0.786) | 0.785(0.778,0.791) | 0.556(0.538,0.575) |
| **22** | 0.382(0.375,0.393) | 0.78(0.752,0.784) | 0.786(0.779,0.79) | 0.557(0.543,0.573) |
| **23** | 0.378(0.373,0.392) | 0.787(0.754,0.79) | 0.789(0.779,0.791) | 0.547(0.537,0.571) |
| **24** | 0.396(0.385,0.437) | 0.743(0.686,0.774) | 0.777(0.75,0.784) | 0.576(0.562,0.608) |
| **25** | 0.395(0.39,0.395) | 0.744(0.744,0.766) | 0.777(0.777,0.781) | 0.576(0.544,0.576) |
| **26** | 0.381(0.375,0.395) | 0.765(0.744,0.785) | 0.786(0.777,0.79) | 0.566(0.557,0.576) |
| **27** | 0.387(0.372,0.394) | 0.774(0.753,0.798) | 0.783(0.778,0.792) | 0.561(0.532,0.571) |
| **28** | 0.394(0.394,0.456) | 0.754(0.694,0.754) | 0.778(0.737,0.778) | 0.571(0.571,0.602) |
| **29** | 0.376(0.372,0.381) | 0.796(0.794,0.798) | 0.789(0.787,0.792) | 0.541(0.531,0.551) |
| **30** | 0.391(0.374,0.394) | 0.769(0.754,0.797) | 0.78(0.778,0.791) | 0.566(0.536,0.57) |
| **31** | 0.373(0.373,0.39) | 0.796(0.771,0.796) | 0.791(0.781,0.791) | 0.532(0.521,0.541) |
| **32** | 0.373(0.373,0.392) | 0.796(0.764,0.826) | 0.791(0.78,0.791) | 0.532(0.515,0.565) |

Table 34. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

| HPCA | Time | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 160.14(158.207,162.27) | 0.105(0.063,0.157) | 160.295(158.4,162.435) |
| **2** | 159.07(156.555,159.705) | 0.11(0.102,0.173) | 159.265(156.782,160.032) |
| **3** | 227.29(220.58,229.47) | 0.11(0.08,0.135) | 227.58(220.783,229.675) |
| **4** | 225.595(223.162,228.65) | 0.11(0.072,0.127) | 225.775(223.45,228.958) |
| **5** | 297.525(294.877,303.31) | 0.12(0.085,0.138) | 297.81(295.153,303.695) |
| **6** | 301.585(299.55,307.025) | 0.115(0.095,0.158) | 301.795(299.805,307.285) |
| **7** | 384.135(379.835,388.283) | 0.135(0.073,0.183) | 384.375(380.238,388.653) |
| **8** | 386.185(380.38,390.907) | 0.15(0.12,0.16) | 386.515(380.815,391.227) |
| **9** | 456.045(453.145,457.408) | 0.17(0.14,0.263) | 456.595(453.745,457.962) |
| **10** | 456.2(448.053,463.75) | 0.19(0.133,0.222) | 456.675(448.495,464.17) |
| **11** | 453.405(448.482,456.342) | 0.21(0.173,0.515) | 453.94(449.292,456.845) |
| **12** | 450.8(446.487,453.668) | 0.22(0.133,0.235) | 451.11(446.995,454.04) |
| **13** | 499.48(491.625,502.94) | 0.235(0.197,0.267) | 499.955(492.095,503.4) |
| **14** | 498.59(486.395,500.81) | 0.195(0.17,0.237) | 499.08(486.9,501.27) |
| **15** | 510.865(509.472,514.317) | 0.2(0.155,0.235) | 511.375(509.9,514.893) |
| **16** | 514.38(506.665,520.85) | 0.17(0.147,0.185) | 514.815(507.085,521.468) |
| **17** | 517.37(514.19,528.412) | 0.18(0.132,0.22) | 517.895(514.682,528.905) |
| **18** | 513.385(504.965,515.657) | 0.145(0.125,0.23) | 513.98(505.32,516.285) |
| **19** | 517.205(513.13,524.365) | 0.24(0.177,0.268) | 517.665(513.75,524.915) |
| **20** | 516.435(513.23,523.005) | 0.21(0.172,0.237) | 517.02(513.688,523.563) |
| **21** | 526.8(520.613,529.625) | 0.17(0.14,0.213) | 528.565(521,530.113) |
| **22** | 517.145(514.51,523.18) | 0.23(0.163,0.278) | 517.67(515.003,523.69) |
| **23** | 448.505(440.025,494.533) | 0.185(0.16,0.21) | 449.235(440.368,495.132) |
| **24** | 443.705(439.673,447.177) | 0.19(0.132,0.243) | 444.185(440.035,447.705) |
| **25** | 410.84(380.967,437.235) | 0.165(0.145,0.22) | 411.32(381.42,437.587) |
| **26** | 382.765(377.34,389.635) | 0.165(0.153,0.235) | 383.115(377.612,390.027) |
| **27** | 377.44(368.298,382.185) | 0.18(0.14,0.198) | 377.735(368.545,382.47) |
| **28** | 374.44(367.972,376.772) | 0.18(0.17,0.228) | 374.905(368.318,377.058) |
| **29** | 382.755(380.878,384.09) | 0.18(0.14,0.25) | 383.15(381.285,384.665) |
| **30** | 377.665(375.368,382.94) | 0.165(0.132,0.185) | 378.025(375.697,383.255) |
| **31** | 378.645(371.202,382.71) | 0.16(0.15,0.198) | 379.02(371.505,383.045) |
| **32** | 374.225(368.89,385.467) | 0.125(0.1,0.185) | 374.445(369.137,385.853) |

Table 35. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 1.064(0.94,1.236) | 4(4,7) | 2.5(1.25,4.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **2** | 1.012(0.837,1.083) | 4(4,4) | 2(1.25,2) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **3** | 3.989(3.741,4.382) | 4(3.25,4) | 1(1,1.75) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0) | 0(0,0) |
| **4** | 4.257(3.748,4.817) | 4(4,4) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0) | 0(0,0) |
| **5** | 5.349(5.186,5.726) | 4(4,4.75) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0) | 0(0,0) |
| **6** | 4.858(4.741,5.097) | 8(4,8) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **7** | 7.028(5.984,7.615) | 5(3,7) | 2(2,2) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0(0,0) |
| **8** | 6.396(6.124,6.66) | 4.5(3.25,7) | 2(1,2) | 10(10,100) | 0.3(0.3,0.4) | 0(0,0) | 0(0,0) |
| **9** | 7.389(7.087,7.643) | 4(3.25,6.25) | 2(1.25,2) | 10(10,100) | 0.3(0.3,0.4) | 0(0,0) | 0(0,0) |
| **10** | 7.391(7.24,7.465) | 7(3.75,7) | 1.5(1,2) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0) | 0(0,0) |
| **11** | 7.853(7.768,7.973) | 3.5(3,4) | 1(1,2) | 55(10,100) | 0.35(0.3,0.4) | 0(0,0) | 0(0,0) |
| **12** | 7.858(7.663,8.192) | 9(4,11) | 1(1,2) | 10(10,77.5) | 0.3(0.3,0.375) | 0.005(0,0.01) | 0(0,0) |
| **13** | 8.453(8.381,8.856) | 5(1.25,7.75) | 1(1,1.75) | 10(0.325,10) | 0.3(0.125,0.3) | 0(0,0) | 0(0,0) |
| **14** | 8.579(8.357,8.916) | 2(1,10.25) | 1(1,1) | 5.05(0.1,10) | 0.2(0.1,0.3) | 0(0,0.008) | 0(0,0) |
| **15** | 9.762(9.243,10.313) | 3.5(2.25,4.75) | 1(1,1) | 10(1,10) | 0.3(0.2,0.3) | 0(0,0) | 0(0,0) |
| **16** | 9.653(9.222,10.073) | 3(1.25,9.25) | 1(1,1) | 5.5(0.325,77.5) | 0.25(0.125,0.375) | 0(0,0.008) | 0(0,0) |
| **17** | 9.45(9.274,10.086) | 5(2.25,10.25) | 1(1,1) | 10(1,100) | 0.3(0.2,0.4) | 0(0,0.008) | 0(0,0) |
| **18** | 9.749(9.456,9.943) | 7(2.25,10.25) | 1(1,1) | 10(3.25,10) | 0.3(0.225,0.3) | 0(0,0.008) | 0(0,0) |
| **19** | 9.659(9.512,10.035) | 7(2.25,10.25) | 1(1,1) | 10(3.25,10) | 0.3(0.225,0.3) | 0(0,0.008) | 0(0,0) |
| **20** | 9.393(9.19,9.431) | 3(1,10.25) | 1(1,1) | 5.5(0.1,10) | 0.25(0.1,0.3) | 0(0,0.008) | 0(0,0) |
| **21** | 9.527(9.349,9.599) | 4.5(1,11) | 1(1,1) | 5.05(0.1,10) | 0.2(0.1,0.3) | 0(0,0.01) | 0(0,0) |
| **22** | 9.713(9.231,10.08) | 3(2.25,10) | 1(1,1) | 10(3.25,10) | 0.3(0.225,0.3) | 0(0,0.008) | 0(0,0) |
| **23** | 9.674(9.371,9.929) | 3(1,7) | 1(1,1) | 10(0.1,77.5) | 0.3(0.1,0.375) | 0(0,0) | 0(0,0) |
| **24** | 9.778(9.338,9.851) | 8(3.25,11) | 1(1,1) | 10(10,77.5) | 0.3(0.3,0.375) | 0(0,0.01) | 0(0,0) |
| **25** | 9.393(9.18,9.759) | 11(8,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.003,0.01) | 0(0,0) |
| **26** | 9.538(9.379,10.089) | 3.5(3,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0.01) | 0(0,0) |
| **27** | 9.394(9.283,9.55) | 7(2,11) | 1(1,1) | 10(1,10) | 0.3(0.2,0.3) | 0.005(0,0.01) | 0(0,0) |
| **28** | 9.794(9.473,10.005) | 11(8,11) | 1(1,1) | 10(10,77.5) | 0.3(0.3,0.375) | 0.01(0,0.01) | 0(0,0) |
| **29** | 9.613(9.369,9.822) | 2.5(1.25,3) | 1(1,1) | 5.5(0.325,10) | 0.25(0.125,0.3) | 0(0,0) | 0(0,0) |
| **30** | 9.608(9.256,9.91) | 7.5(2.25,11) | 1(1,1) | 10(3.25,10) | 0.3(0.225,0.3) | 0(0,0.01) | 0(0,0) |
| **31** | 9.516(9.42,9.634) | 2(1,9.5) | 1(1,1) | 0.55(0.1,7.75) | 0.15(0.1,0.275) | 0(0,0.008) | 0(0,0) |
| **32** | 9.6(9.318,10.235) | 3.5(2,4) | 1(1,1) | 10(1,100) | 0.3(0.2,0.4) | 0(0,0) | 0(0,0) |

Table 36. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

#### 2.2.3.6 Left Temporal (5)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 37)

The User, System and Elapsed Time group by number of HPCA (Table 38): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 39): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0(0,0) | 0.001(0.001,0.001) | 1(1,1) | 1(1,1) |
| **2** | 0.035(0.015,0.05) | 0.172(0.114,0.222) | 0.983(0.974,0.992) | 0.91(0.884,0.941) |
| **3** | 0.028(0.013,0.059) | 0.178(0.116,0.224) | 0.986(0.97,0.993) | 0.907(0.883,0.94) |
| **4** | 0.155(0.079,0.202) | 0.206(0.173,0.313) | 0.919(0.893,0.96) | 0.891(0.831,0.909) |
| **5** | 0.203(0.131,0.243) | 0.174(0.151,0.222) | 0.893(0.87,0.932) | 0.909(0.882,0.922) |
| **6** | 0.191(0.137,0.191) | 0.411(0.39,0.431) | 0.9(0.899,0.929) | 0.769(0.76,0.791) |
| **7** | 0.178(0.138,0.193) | 0.41(0.388,0.429) | 0.906(0.898,0.928) | 0.77(0.76,0.791) |
| **8** | 0.249(0.15,0.255) | 0.454(0.454,0.466) | 0.866(0.863,0.922) | 0.739(0.731,0.739) |
| **9** | 0.253(0.24,0.255) | 0.436(0.393,0.456) | 0.864(0.863,0.872) | 0.751(0.738,0.779) |
| **10** | 0.279(0.258,0.298) | 0.569(0.542,0.578) | 0.849(0.838,0.862) | 0.657(0.651,0.684) |
| **11** | 0.322(0.246,0.427) | 0.513(0.495,0.533) | 0.824(0.757,0.869) | 0.705(0.694,0.717) |
| **12** | 0.38(0.358,0.484) | 0.55(0.517,0.565) | 0.787(0.719,0.801) | 0.671(0.66,0.696) |
| **13** | 0.433(0.3,0.48) | 0.546(0.493,0.546) | 0.753(0.721,0.836) | 0.676(0.676,0.713) |
| **14** | 0.452(0.331,0.5) | 0.594(0.59,0.594) | 0.739(0.707,0.818) | 0.641(0.639,0.641) |
| **15** | 0.411(0.381,0.429) | 0.578(0.571,0.595) | 0.768(0.756,0.787) | 0.651(0.639,0.656) |
| **16** | 0.428(0.348,0.494) | 0.611(0.578,0.63) | 0.757(0.711,0.807) | 0.629(0.614,0.652) |
| **17** | 0.425(0.4,0.454) | 0.624(0.582,0.645) | 0.758(0.739,0.775) | 0.619(0.599,0.65) |
| **18** | 0.472(0.427,0.52) | 0.625(0.58,0.642) | 0.726(0.693,0.757) | 0.618(0.603,0.65) |
| **19** | 0.434(0.4,0.503) | 0.632(0.602,0.643) | 0.752(0.705,0.775) | 0.608(0.602,0.631) |
| **20** | 0.486(0.427,0.522) | 0.638(0.591,0.64) | 0.717(0.691,0.757) | 0.608(0.603,0.642) |
| **21** | 0.424(0.401,0.484) | 0.642(0.579,0.649) | 0.759(0.747,0.774) | 0.603(0.596,0.651) |
| **22** | 0.43(0.428,0.444) | 0.607(0.584,0.639) | 0.755(0.745,0.756) | 0.629(0.604,0.647) |
| **23** | 0.437(0.428,0.522) | 0.62(0.579,0.648) | 0.75(0.701,0.756) | 0.619(0.597,0.651) |
| **24** | 0.43(0.425,0.454) | 0.602(0.575,0.637) | 0.755(0.739,0.758) | 0.631(0.606,0.655) |
| **25** | 0.43(0.403,0.443) | 0.594(0.577,0.605) | 0.755(0.746,0.772) | 0.642(0.631,0.654) |
| **26** | 0.428(0.422,0.499) | 0.611(0.571,0.638) | 0.756(0.707,0.76) | 0.626(0.606,0.659) |
| **27** | 0.475(0.428,0.522) | 0.633(0.571,0.633) | 0.724(0.691,0.756) | 0.609(0.609,0.658) |
| **28** | 0.427(0.422,0.5) | 0.612(0.574,0.641) | 0.757(0.707,0.76) | 0.624(0.602,0.656) |
| **29** | 0.423(0.42,0.44) | 0.574(0.57,0.605) | 0.759(0.749,0.761) | 0.654(0.631,0.657) |
| **30** | 0.426(0.422,0.496) | 0.6(0.573,0.633) | 0.757(0.709,0.76) | 0.634(0.61,0.657) |
| **31** | 0.423(0.405,0.497) | 0.614(0.574,0.634) | 0.759(0.708,0.772) | 0.625(0.608,0.656) |
| **32** | 0.474(0.427,0.521) | 0.607(0.573,0.634) | 0.724(0.692,0.757) | 0.631(0.608,0.657) |

Table 37. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

| HPCA | Time | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 85.22(82.24,88.103) | 0.085(0.072,0.18) | 85.285(82.385,88.298) |
| **2** | 109.025(107.6,109.975) | 0.05(0.033,0.1) | 109.12(107.698,110.093) |
| **3** | 152.06(148.175,154.522) | 0.085(0.06,0.118) | 152.39(148.273,154.65) |
| **4** | 159.19(157.465,162.08) | 0.075(0.06,0.088) | 159.3(157.608,162.18) |
| **5** | 145.71(144.542,148.22) | 0.08(0.063,0.097) | 145.815(144.602,148.353) |
| **6** | 211.98(209.11,214.64) | 0.115(0.083,0.158) | 212.335(209.238,214.767) |
| **7** | 197.115(195.108,202.04) | 0.13(0.065,0.168) | 197.225(195.288,202.237) |
| **8** | 260.785(255.61,262.813) | 0.115(0.085,0.15) | 260.945(255.775,262.975) |
| **9** | 239.12(235.985,245.053) | 0.12(0.095,0.137) | 239.295(236.23,245.58) |
| **10** | 294.78(293.9,300.085) | 0.135(0.11,0.165) | 295.025(294.45,300.273) |
| **11** | 284.495(279.705,287.048) | 0.12(0.093,0.165) | 284.75(279.882,287.257) |
| **12** | 340.275(336.577,342.192) | 0.14(0.132,0.155) | 340.51(336.818,342.448) |
| **13** | 328.79(325.352,333.43) | 0.13(0.1,0.165) | 329.065(325.553,333.665) |
| **14** | 343.705(339.407,348.03) | 0.145(0.103,0.168) | 343.935(339.817,348.188) |
| **15** | 343.96(341.745,346.987) | 0.12(0.103,0.137) | 344.195(341.932,347.185) |
| **16** | 368.495(365.69,371.485) | 0.115(0.09,0.168) | 368.755(365.975,371.655) |
| **17** | 372.245(368.833,377.332) | 0.15(0.118,0.167) | 372.48(369.087,377.605) |
| **18** | 371.535(369.907,374.832) | 0.135(0.113,0.16) | 371.755(370.12,375.06) |
| **19** | 371.565(366.975,376.44) | 0.14(0.1,0.158) | 371.755(367.173,376.758) |
| **20** | 371.87(365.462,375.325) | 0.15(0.112,0.16) | 372.07(365.8,375.518) |
| **21** | 369.815(367.247,378.235) | 0.12(0.11,0.155) | 370.055(367.9,378.382) |
| **22** | 371.575(370.975,373.905) | 0.155(0.14,0.21) | 371.86(371.255,374.35) |
| **23** | 366.97(361.977,371.255) | 0.135(0.123,0.14) | 367.155(362.295,371.45) |
| **24** | 366.125(363.695,370.655) | 0.17(0.143,0.242) | 366.335(363.942,370.962) |
| **25** | 369.765(367.602,373.958) | 0.14(0.125,0.17) | 370.06(367.815,374.215) |
| **26** | 379.255(372.052,384.143) | 0.12(0.087,0.137) | 379.455(372.287,384.585) |
| **27** | 369.96(368.803,373.07) | 0.16(0.123,0.17) | 370.125(369.037,373.43) |
| **28** | 379.885(374.61,382.557) | 0.17(0.13,0.197) | 380.115(374.832,383.03) |
| **29** | 378.04(373.005,380.638) | 0.16(0.132,0.178) | 378.335(373.4,380.917) |
| **30** | 377.445(366.725,381.855) | 0.175(0.137,0.205) | 377.785(367.048,382.265) |
| **31** | 374.415(369.205,379.86) | 0.13(0.12,0.195) | 374.705(369.527,380.072) |
| **32** | 371.06(366.777,378.42) | 0.16(0.125,0.178) | 371.315(367.035,378.672) |

Table 38. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 0.006(0.005,0.007) | 5(4,8) | 2(2,3) | 100(25.075,100) | 0.4(0.175,0.4) | 0(0,0) | 0(0,0) |
| **2** | 1.415(1.343,1.713) | 9(4,12) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.005(0,0.01) | 0(0,0) |
| **3** | 1.677(1.494,1.932) | 3.5(3,12) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0(0,0.01) | 0(0,0) |
| **4** | 7.154(6.448,7.419) | 4(4,4) | 1.5(1,2.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **5** | 5.96(5.559,7.008) | 8(4,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **6** | 7.504(7.116,8.419) | 4(4,4) | 2(2,3) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **7** | 8.101(7.478,8.806) | 4(4,10) | 2.5(2,3) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.008) | 0(0,0) |
| **8** | 9.462(8.715,10.392) | 4(1.25,4) | 2(2,2) | 100(0.325,100) | 0.4(0.125,0.4) | 0(0,0) | 0(0,0) |
| **9** | 9.851(9.118,10.531) | 4(4,12) | 2(2,2.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.01) | 0(0,0) |
| **10** | 9.943(9.804,10.184) | 8(4,12) | 3(3,3) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **11** | 10.151(9.916,10.718) | 4(4,10) | 2(1,3) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.008) | 0(0,0) |
| **12** | 11.566(11.277,11.967) | 4(1.75,4) | 1(1,2) | 100(25.075,100) | 0.4(0.175,0.4) | 0(0,0) | 0(0,0) |
| **13** | 11.326(10.992,12.048) | 4(4,4) | 1(1,2.75) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **14** | 11.241(10.954,11.54) | 4(4,4) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **15** | 11.455(11.111,11.86) | 4(3.25,4) | 1.5(1,2) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0) | 0(0,0) |
| **16** | 12.005(11.844,12.357) | 4(1,4) | 1(1,2.5) | 100(0.1,100) | 0.4(0.1,0.4) | 0(0,0) | 0(0,0) |
| **17** | 11.657(11.452,12.376) | 4(1.75,4) | 1(1,2) | 100(2.575,100) | 0.4(0.15,0.4) | 0(0,0) | 0(0,0) |
| **18** | 12.144(11.743,12.628) | 4(1.25,4) | 1(1,1) | 100(0.325,100) | 0.4(0.125,0.4) | 0(0,0) | 0(0,0) |
| **19** | 12.109(11.637,12.573) | 4(3,7) | 1(1,2.5) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0) | 0(0,0) |
| **20** | 12.622(11.901,12.717) | 4(2.5,4) | 1(1,1) | 100(25.75,100) | 0.4(0.25,0.4) | 0(0,0) | 0(0,0) |
| **21** | 12.871(12.405,13.751) | 3(1.25,4) | 1.5(1,2) | 50.5(0.325,100) | 0.3(0.125,0.4) | 0(0,0) | 0(0,0) |
| **22** | 12.097(12.048,12.454) | 3.5(1.5,4) | 1(1,1.75) | 55(2.575,100) | 0.35(0.15,0.4) | 0(0,0) | 0(0,0) |
| **23** | 12.474(11.857,13.081) | 3.5(1,4) | 1(1,1.75) | 55(0.1,100) | 0.35(0.1,0.4) | 0(0,0) | 0(0,0) |
| **24** | 11.861(11.441,12.459) | 3.5(1,4) | 1(1,1.75) | 55(0.1,100) | 0.35(0.1,0.4) | 0(0,0) | 0(0,0) |
| **25** | 12.064(11.699,12.139) | 3.5(1.25,4) | 1(1,2) | 55(0.325,100) | 0.35(0.125,0.4) | 0(0,0) | 0(0,0) |
| **26** | 12.856(12.322,13.023) | 3.5(1,4) | 1(1,1.75) | 55(0.1,100) | 0.35(0.1,0.4) | 0(0,0) | 0(0,0) |
| **27** | 12.602(11.965,12.783) | 4(1,4) | 1(1,1) | 100(0.1,100) | 0.4(0.1,0.4) | 0(0,0) | 0(0,0) |
| **28** | 12.137(11.7,13.283) | 3.5(1.25,4) | 1(1,1.75) | 55(0.325,100) | 0.35(0.125,0.4) | 0(0,0) | 0(0,0) |
| **29** | 11.8(11.454,12.45) | 1.5(1,3.75) | 1(1,1) | 0.55(0.1,77.5) | 0.15(0.1,0.375) | 0(0,0) | 0(0,0) |
| **30** | 12.408(12.038,12.576) | 3.5(1,4) | 1(1,1) | 55(0.1,100) | 0.35(0.1,0.4) | 0(0,0) | 0(0,0) |
| **31** | 12.383(12.078,12.646) | 4(1.25,4) | 1(1,1.75) | 100(0.325,100) | 0.4(0.125,0.4) | 0(0,0) | 0(0,0) |
| **32** | 12.327(11.821,12.582) | 3(1,4) | 1(1,1) | 50.5(0.1,100) | 0.3(0.1,0.4) | 0(0,0) | 0(0,0) |

Table 39. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

#### 2.2.3.7 Right Temporal (6)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 40)

The User, System and Elapsed Time group by number of HPCA (Table 41): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 42): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.016(0.005,0.025) | 0.193(0.128,0.209) | 0.992(0.988,0.998) | 0.899(0.89,0.935) |
| **2** | 0.016(0.016,0.075) | 0.378(0.209,0.401) | 0.992(0.962,0.992) | 0.801(0.789,0.893) |
| **3** | 0.133(0.104,0.152) | 0.577(0.532,0.675) | 0.931(0.921,0.947) | 0.678(0.619,0.705) |
| **4** | 0.263(0.263,0.263) | 0.351(0.351,0.351) | 0.858(0.858,0.858) | 0.81(0.81,0.81) |
| **5** | 0.395(0.378,0.395) | 0.468(0.468,0.525) | 0.778(0.778,0.789) | 0.733(0.7,0.733) |
| **6** | 0.4(0.392,0.411) | 0.567(0.566,0.574) | 0.774(0.767,0.78) | 0.674(0.67,0.676) |
| **7** | 0.387(0.378,0.477) | 0.835(0.76,0.879) | 0.783(0.727,0.789) | 0.443(0.425,0.541) |
| **8** | 0.348(0.342,0.359) | 0.856(0.751,0.891) | 0.807(0.801,0.811) | 0.468(0.447,0.551) |
| **9** | 0.48(0.427,0.54) | 0.774(0.651,0.86) | 0.72(0.678,0.757) | 0.498(0.473,0.615) |
| **10** | 0.443(0.434,0.53) | 0.832(0.7,0.849) | 0.746(0.698,0.752) | 0.468(0.467,0.563) |
| **11** | 0.524(0.462,0.57) | 0.779(0.718,0.927) | 0.693(0.655,0.733) | 0.502(0.447,0.564) |
| **12** | 0.482(0.437,0.502) | 0.793(0.749,0.842) | 0.727(0.723,0.751) | 0.496(0.447,0.545) |
| **13** | 0.633(0.515,0.633) | 0.944(0.929,0.952) | 0.615(0.615,0.704) | 0.33(0.318,0.351) |
| **14** | 0.616(0.608,0.631) | 0.795(0.774,0.916) | 0.619(0.615,0.629) | 0.511(0.339,0.522) |
| **15** | 0.676(0.634,0.75) | 0.979(0.815,0.993) | 0.577(0.51,0.607) | 0.393(0.299,0.439) |
| **16** | 0.625(0.558,0.648) | 0.979(0.85,1.003) | 0.619(0.6,0.664) | 0.394(0.392,0.411) |
| **17** | 0.62(0.562,0.746) | 0.985(0.832,0.985) | 0.616(0.514,0.661) | 0.4(0.4,0.423) |
| **18** | 0.619(0.562,0.626) | 0.908(0.79,0.986) | 0.616(0.611,0.662) | 0.408(0.396,0.512) |
| **19** | 0.563(0.557,0.563) | 0.987(0.987,1.005) | 0.661(0.661,0.665) | 0.397(0.387,0.4) |
| **20** | 0.62(0.563,0.667) | 0.976(0.8,0.988) | 0.615(0.583,0.66) | 0.398(0.363,0.49) |
| **21** | 0.641(0.629,0.679) | 0.904(0.792,0.985) | 0.603(0.575,0.609) | 0.411(0.333,0.495) |
| **22** | 0.591(0.558,0.66) | 0.988(0.846,0.99) | 0.638(0.589,0.664) | 0.396(0.362,0.418) |
| **23** | 0.619(0.563,0.665) | 0.975(0.797,0.982) | 0.616(0.584,0.66) | 0.402(0.397,0.492) |
| **24** | 0.621(0.577,0.665) | 0.907(0.793,0.983) | 0.615(0.584,0.65) | 0.41(0.396,0.51) |
| **25** | 0.562(0.557,0.621) | 0.983(0.788,1.004) | 0.662(0.615,0.665) | 0.402(0.397,0.513) |
| **26** | 0.65(0.627,0.719) | 0.837(0.781,0.952) | 0.595(0.538,0.61) | 0.42(0.404,0.518) |
| **27** | 0.66(0.633,0.721) | 0.866(0.84,1.007) | 0.591(0.536,0.615) | 0.396(0.297,0.417) |
| **28** | 0.558(0.547,0.558) | 1.022(1.006,1.038) | 0.664(0.664,0.673) | 0.387(0.371,0.391) |
| **29** | 0.59(0.554,0.663) | 0.999(0.879,1.028) | 0.64(0.586,0.667) | 0.387(0.344,0.408) |
| **30** | 0.618(0.559,0.674) | 1.005(0.993,1.031) | 0.617(0.579,0.664) | 0.378(0.301,0.391) |
| **31** | 0.588(0.559,0.642) | 1.009(0.999,1.031) | 0.641(0.605,0.663) | 0.386(0.317,0.389) |
| **32** | 0.643(0.617,0.676) | 0.996(0.803,1.015) | 0.6(0.577,0.618) | 0.344(0.293,0.505) |

Table 40. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

| HPCA | Time | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 129.065(127.987,129.665) | 0.105(0.08,0.148) | 129.24(128.157,129.772) |
| **2** | 131.62(129.708,133.14) | 0.075(0.043,0.108) | 131.7(129.818,133.313) |
| **3** | 188.73(187.417,190.437) | 0.095(0.053,0.118) | 188.795(187.573,190.62) |
| **4** | 185.265(182.867,185.865) | 0.095(0.065,0.107) | 185.405(183.045,186.02) |
| **5** | 242.205(239.267,246.69) | 0.085(0.065,0.105) | 242.405(239.465,247.047) |
| **6** | 257.465(254.97,260.955) | 0.11(0.075,0.132) | 257.69(255.147,261.188) |
| **7** | 283.29(280.975,286.67) | 0.1(0.06,0.12) | 283.525(281.355,286.877) |
| **8** | 281.58(276.673,282.965) | 0.135(0.09,0.155) | 281.795(276.958,283.393) |
| **9** | 319.79(316.832,322.405) | 0.145(0.11,0.212) | 320.04(317.158,322.702) |
| **10** | 321.48(317.448,322.82) | 0.145(0.132,0.182) | 321.75(317.905,323.117) |
| **11** | 326.51(324.083,327.66) | 0.16(0.103,0.185) | 326.7(324.445,327.955) |
| **12** | 326.705(323.975,329.02) | 0.14(0.12,0.17) | 326.975(324.205,329.268) |
| **13** | 361.53(355.472,364.057) | 0.14(0.13,0.155) | 361.78(355.842,364.308) |
| **14** | 354.99(350.935,358.965) | 0.145(0.115,0.175) | 355.265(351.178,359.255) |
| **15** | 377.985(375.518,382.927) | 0.135(0.11,0.14) | 378.175(375.838,383.157) |
| **16** | 376.9(372.323,378.96) | 0.155(0.117,0.17) | 377.15(372.575,379.31) |
| **17** | 371.96(370.3,376.8) | 0.17(0.145,0.197) | 372.39(370.755,377.015) |
| **18** | 373.455(369.725,377.683) | 0.16(0.142,0.168) | 373.705(369.98,378.09) |
| **19** | 374.11(370.278,375.537) | 0.165(0.142,0.253) | 374.39(370.553,376.165) |
| **20** | 372.82(367.46,391.758) | 0.17(0.118,0.208) | 373.38(367.85,392.828) |
| **21** | 375.65(371.742,382.527) | 0.16(0.132,0.185) | 376.06(372.17,383.33) |
| **22** | 404.245(401.195,411.692) | 0.205(0.155,0.257) | 405.55(402.545,413.245) |
| **23** | 404.135(397.807,409.91) | 0.195(0.172,0.27) | 405.455(399.332,411.695) |
| **24** | 425(422.528,429.973) | 0.265(0.25,0.295) | 427.77(424.772,432.645) |
| **25** | 428.22(418.313,430.28) | 0.3(0.28,0.317) | 430.76(420.25,432.757) |
| **26** | 425.335(420.537,429.565) | 0.265(0.212,0.297) | 427.515(422.198,432.053) |
| **27** | 426.23(420.87,434.488) | 0.195(0.173,0.207) | 428.8(422.722,436.47) |
| **28** | 436.95(432.378,441.75) | 0.295(0.24,0.308) | 439.425(434.625,443.858) |
| **29** | 439.225(437.29,443.38) | 0.3(0.275,0.325) | 441.79(439.798,445.598) |
| **30** | 440.795(435.11,444.865) | 0.315(0.222,0.405) | 443.65(437.67,447.873) |
| **31** | 438.175(434.988,449.245) | 0.275(0.215,0.347) | 440.525(436.997,452.593) |
| **32** | 413.435(405.858,421.507) | 0.315(0.275,0.358) | 415.93(408.315,424.407) |

Table 41. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for right temporal region of the brain

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | index | K | Tau | Lambda | Eta | Kappa |
| **1** | 2.163(1.784,2.666) | 4(4,7) | 3(2,5) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0) | 0(0,0) |
| **2** | 3.493(3.206,3.895) | 8(5,9) | 1(1,1) | 0.1(0.1,100) | 0.1(0.1,0.4) | 0(0,0.01) | 0(0,0) |
| **3** | 7.92(7.159,8.081) | 4(3.25,4) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0) | 0(0,0) |
| **4** | 7.044(6.865,7.283) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **5** | 10.212(9.271,10.466) | 12(12,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **6** | 9.244(8.908,9.742) | 12(8,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |
| **7** | 10.368(9.767,10.924) | 11(11,12) | 1(1,1.75) | 10(10,100) | 0.3(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **8** | 9.538(9.466,9.615) | 7.5(3.25,10) | 1(1,1) | 10(3.25,77.5) | 0.3(0.225,0.375) | 0(0,0.01) | 0(0,0) |
| **9** | 10.974(10.683,11.17) | 7.5(3.25,11.75) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.005(0,0.01) | 0(0,0) |
| **10** | 10.918(10.814,11.297) | 5(3,8) | 1(1,1.75) | 10(10,77.5) | 0.3(0.3,0.375) | 0(0,0) | 0(0,0.008) |
| **11** | 11.343(11.184,11.869) | 9.5(3,12) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.005(0,0.01) | 0(0,0) |
| **12** | 11.105(10.876,11.748) | 9.5(4.75,11.75) | 2(1,2) | 55(10,100) | 0.35(0.3,0.4) | 0.005(0,0.01) | 0(0,0.008) |
| **13** | 12.44(12.28,12.601) | 1.5(1,2.75) | 1(1,1) | 0.55(0.1,7.75) | 0.15(0.1,0.275) | 0(0,0) | 0.01(0.01,0.01) |
| **14** | 12.457(12.298,12.644) | 6.5(4.25,11) | 1(1,1) | 100(25.075,100) | 0.4(0.175,0.4) | 0(0,0.008) | 0(0,0.01) |
| **15** | 12.903(12.622,13.16) | 9.5(5,11) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.005(0,0.01) | 0.01(0.003,0.01) |
| **16** | 12.606(12.482,12.743) | 7.5(7,10.25) | 1(1,1) | 10(10,100) | 0.3(0.3,0.4) | 0(0,0.008) | 0(0,0.01) |
| **17** | 12.842(12.67,13.169) | 11(8.25,11) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0.003,0.01) | 0(0,0.01) |
| **18** | 12.482(12.211,12.73) | 7.5(4,11) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0(0,0.01) | 0(0,0) |
| **19** | 12.458(12.098,12.665) | 11(7,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0,0.01) | 0(0,0.008) |
| **20** | 12.547(12.351,12.934) | 11(5.75,11) | 1(1,1) | 10(10,100) | 0.3(0.3,0.4) | 0.01(0.003,0.01) | 0(0,0.008) |
| **21** | 12.585(12.276,12.861) | 11.5(11,12) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0.01,0.01) | 0.005(0,0.01) |
| **22** | 12.882(12.423,13.175) | 5.5(4,10) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0(0,0.008) | 0(0,0.01) |
| **23** | 12.717(12.582,12.8) | 11(4.75,11) | 1(1,1) | 10(10,100) | 0.3(0.3,0.4) | 0.01(0,0.01) | 0(0,0.008) |
| **24** | 12.738(12.112,12.913) | 8(4.75,11) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0.01) | 0(0,0.008) |
| **25** | 12.371(12.063,12.813) | 9.5(7,11) | 1(1,1) | 10(10,100) | 0.3(0.3,0.4) | 0.005(0,0.01) | 0(0,0) |
| **26** | 12.879(12.612,13.23) | 11.5(7.25,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0,0.01) | 0.005(0,0.01) |
| **27** | 12.676(12.547,13.261) | 8(4.75,10.75) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0(0,0.01) | 0.01(0.01,0.01) |
| **28** | 12.516(11.852,12.686) | 9.5(7.25,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.005(0,0.01) | 0(0,0) |
| **29** | 12.722(12.062,13.04) | 11(8.75,11.75) | 1(1,1) | 10(10,100) | 0.3(0.3,0.4) | 0.01(0.003,0.01) | 0(0,0.01) |
| **30** | 12.605(12.376,12.915) | 8.5(7,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.005(0,0.01) | 0(0,0.01) |
| **31** | 12.343(12.085,12.642) | 7(4,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0(0,0.01) | 0(0,0.008) |
| **32** | 12.809(12.416,13.032) | 9(4,11) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.005(0,0.01) | 0.005(0,0.01) |

Table 42. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

#### 2.2.3.8 Figures

The MSPE over Number of HPCA group by Regions: Figure 30

The Correlation over Number of HPCA group by Regions: Figure 31

The Elapsed Time over Number of HPCA group by Regions: Figure 32

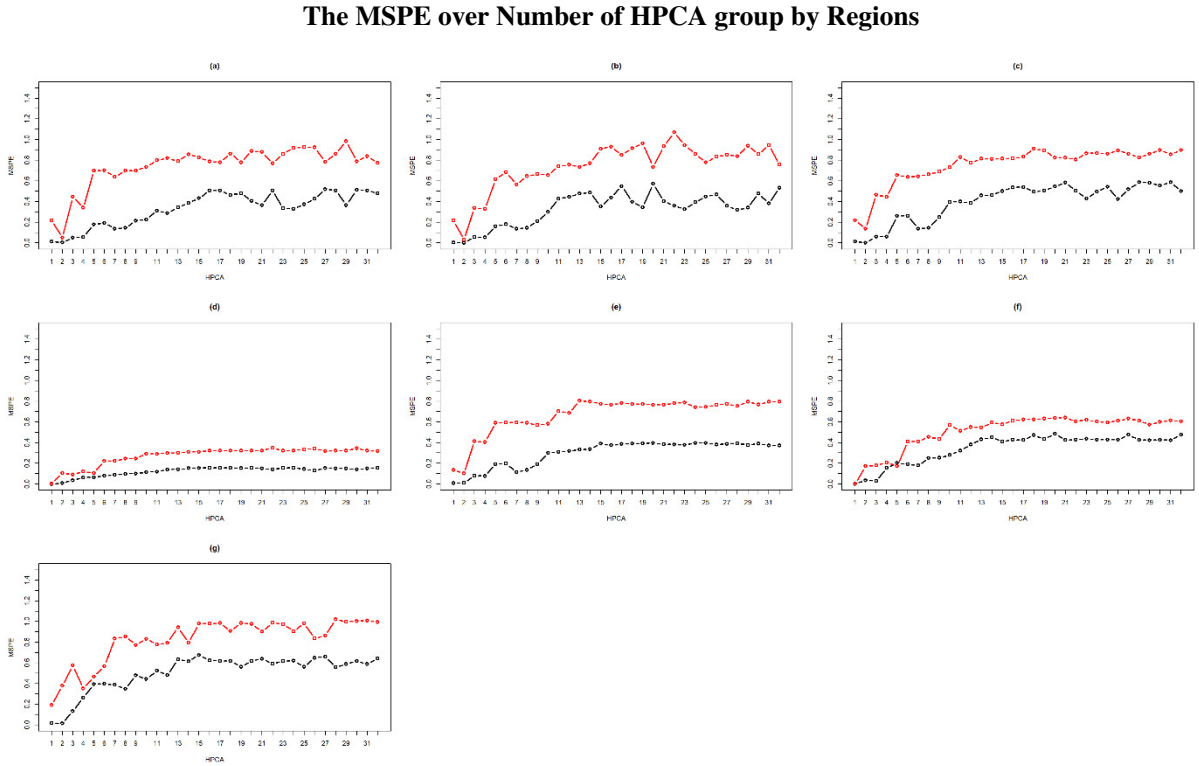



Figure 30. (a-g) Median of mean square prediction error (MSPE) for train (black solid line) and test (red solid line) in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

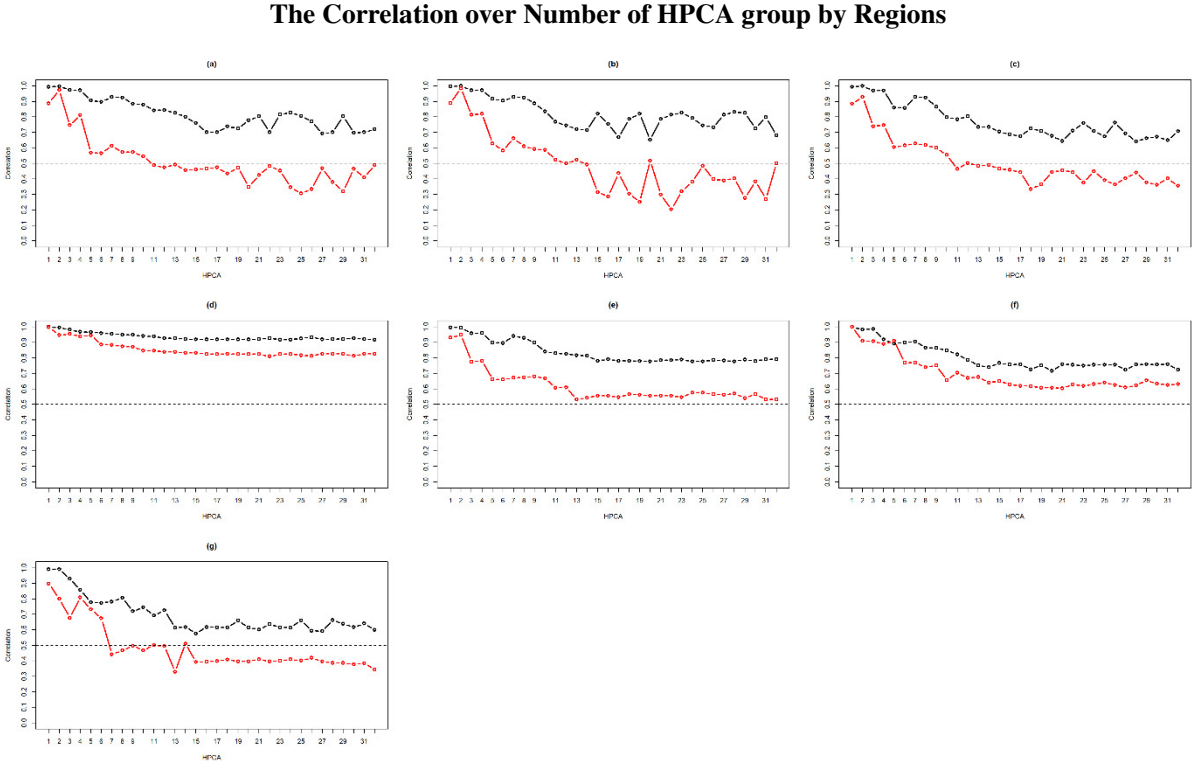



Figure 31. (a-g) Median of correlation for train (black solid line) and test (red solid line) in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

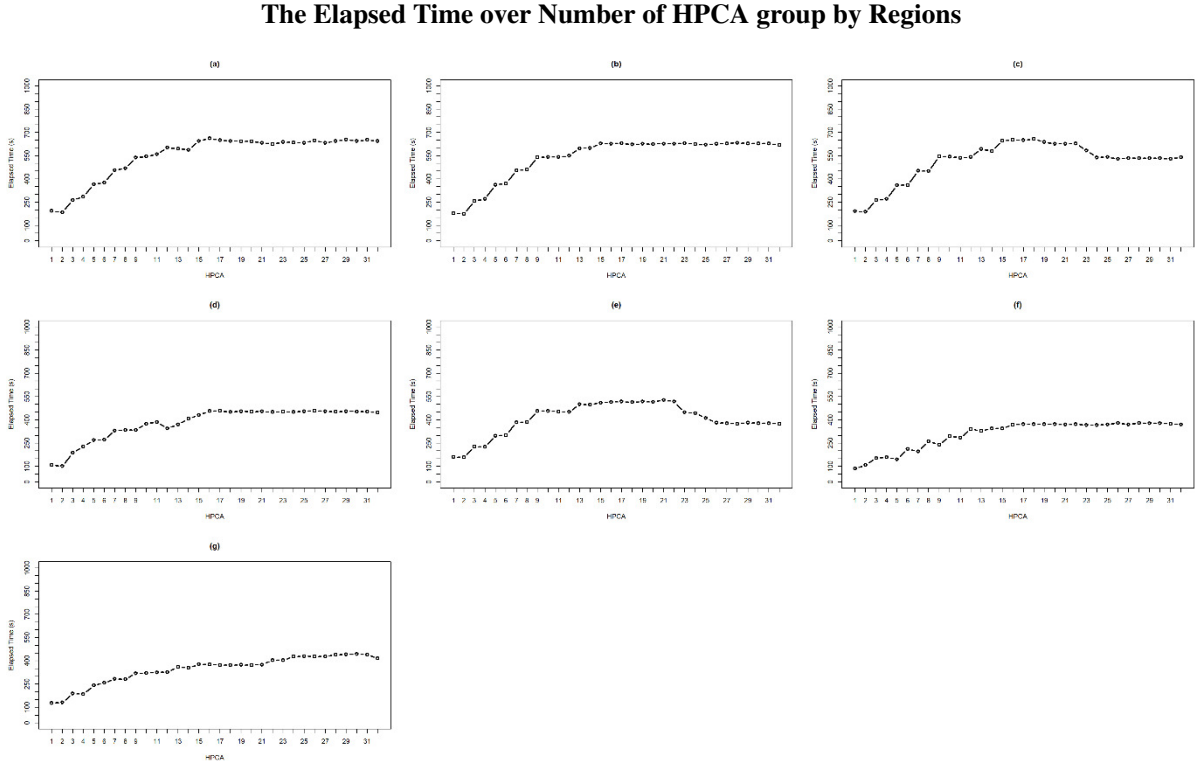



Figure 32. (a-g) Median of elapsed time in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

*2.2.4. Conclusion .*

According to the Figure 30, the MSPE increased by adding HPCA from 1 to KLM in all regions. It also indicates that the difference between training and testing exists. The Figure 31 shows the correlation. The highest correlation is in the first HPCA in all regions fro both training and testing datasets. The elapsed time is also increasing by adding HPCA.(Figure 32)

We conclude that the first,second or third HPCA has the best performance based on the MSPE, correlation and elapsed times in all region of the brain. It shows that in some regions the second HPCA has the best performance than others.

## 3. The Visual Odd Ball Task

### *3.1. Standard Stimuli*

*3.1.1. The HPCA Decomposition*

#### 3.1.1.1 The Functional dimension

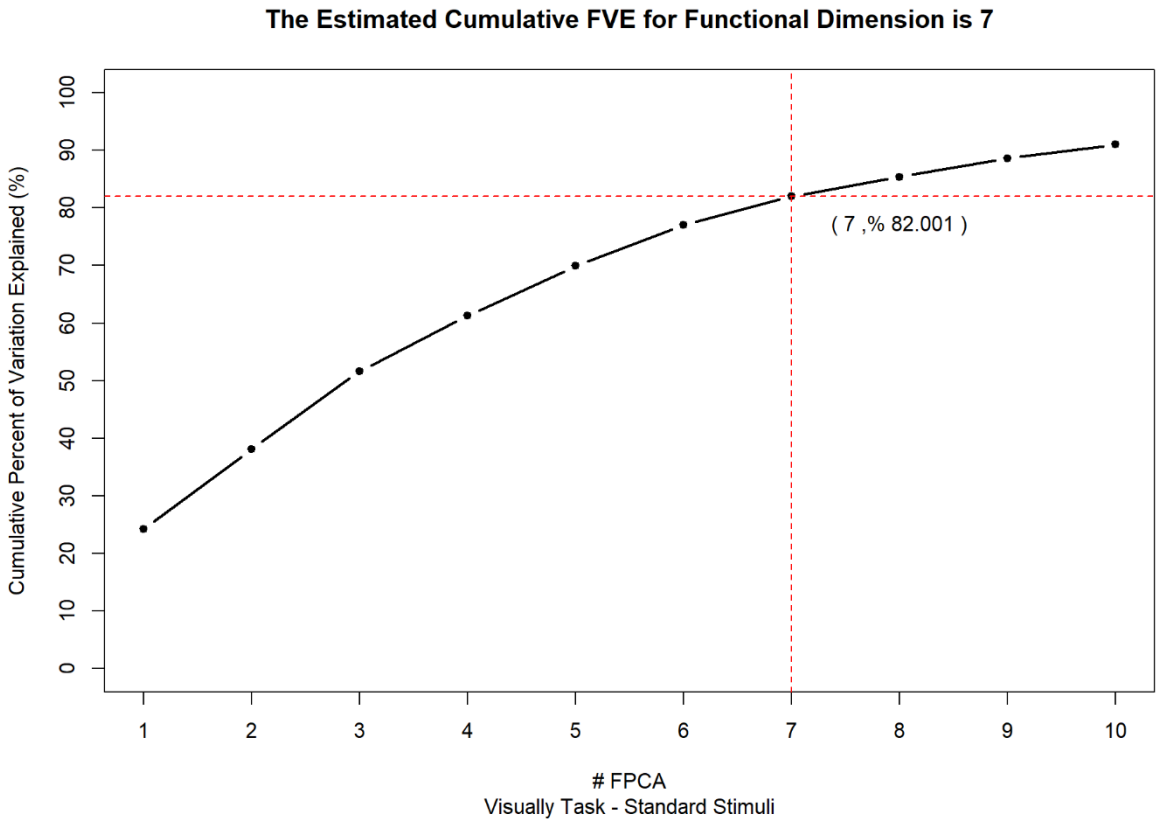



Figure 33. The estimated cumulative fraction of variations (FVE) for functional dimension.

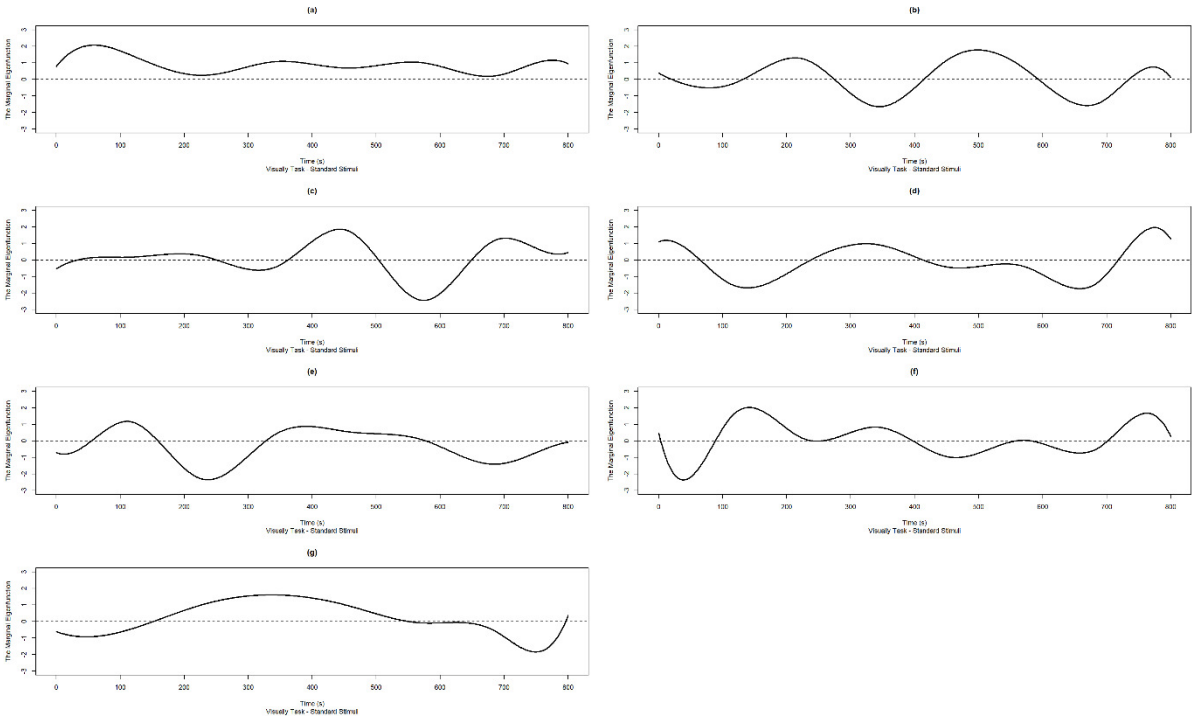



Figure 34. (a, g) Estimated first to seven leading functional marginal eigenfunctions.

According to the Figure 33, the first seven marginal functional principal component analysis (FPCA) capture at least 85% of variation in this dimension. The Figure 34 plots estimated first to seven leading functional marginal eigenfunctions on the x-axis (time).

#### 3.1.1.2 The Longitudinal dimension

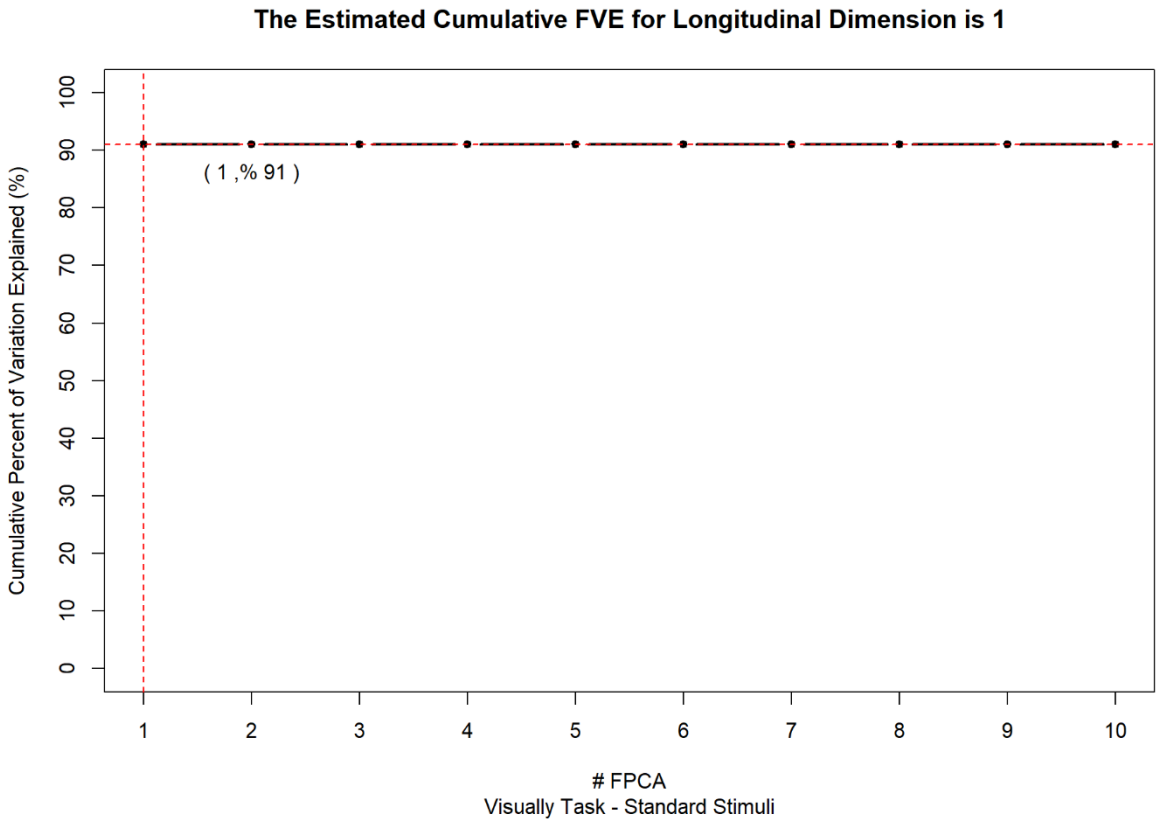



Figure 35. The estimated cumulative fraction of variations (FVE) for longitudinal dimension.

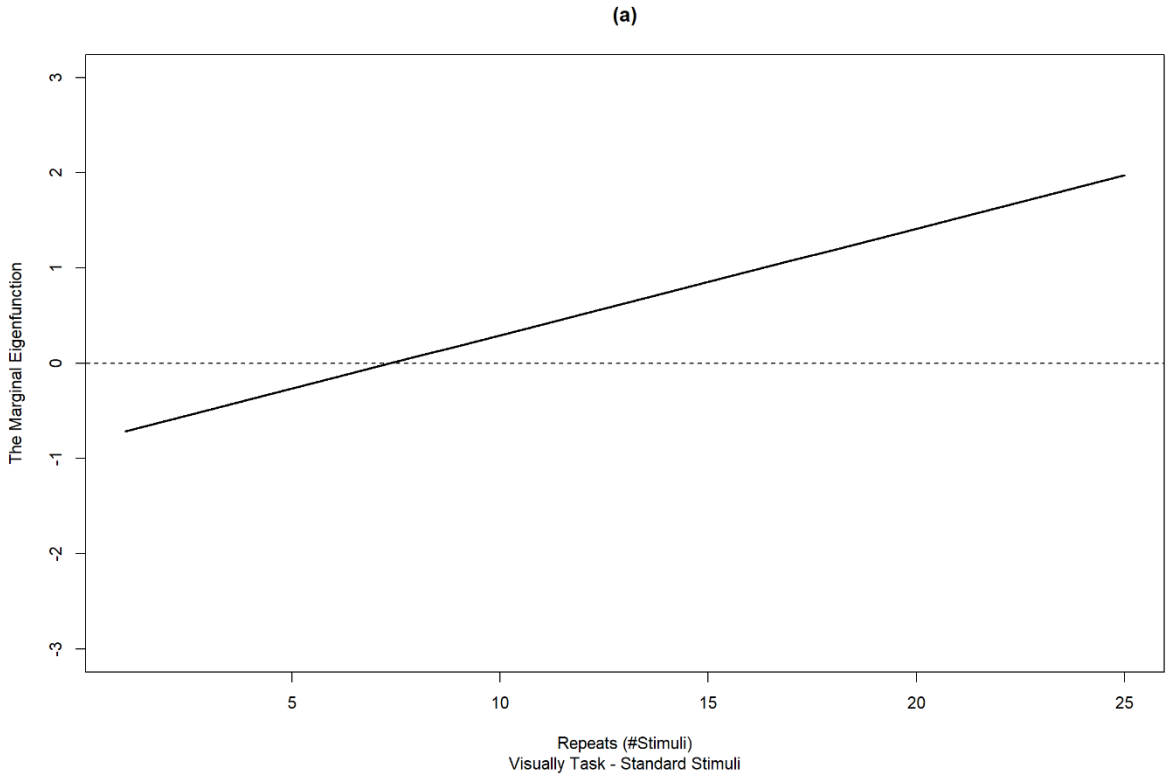



Figure 36. Estimated first leading longitudinal marginal eigenfunctions.

According to the Figure 35, the first marginal functional principal component analysis (FPCA) capture at least 90% of variation in this dimension. The Figure 36 plots estimated first leading longitudinal marginal eigenfunctions on the receptions.

#### 3.1.1.3 The Regional dimension

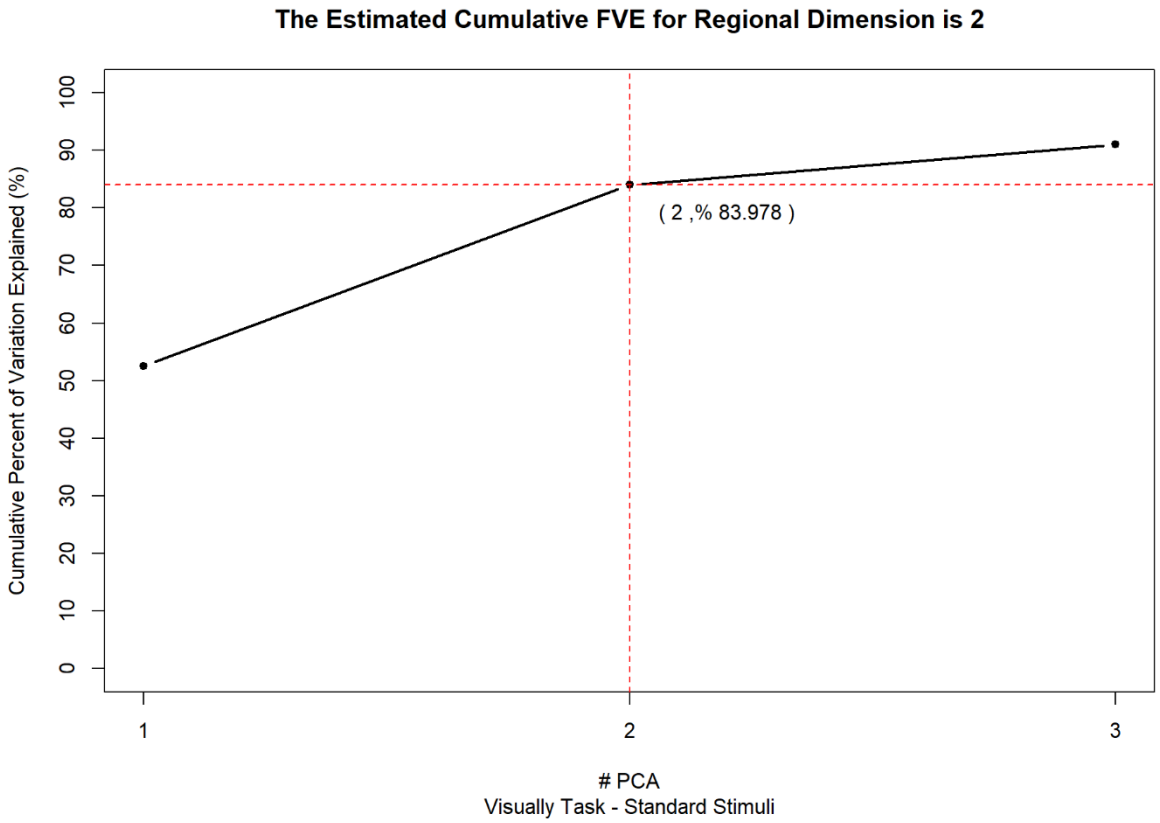



Figure 37. The estimated cumulative fraction of variations (FVE) for regional dimension.

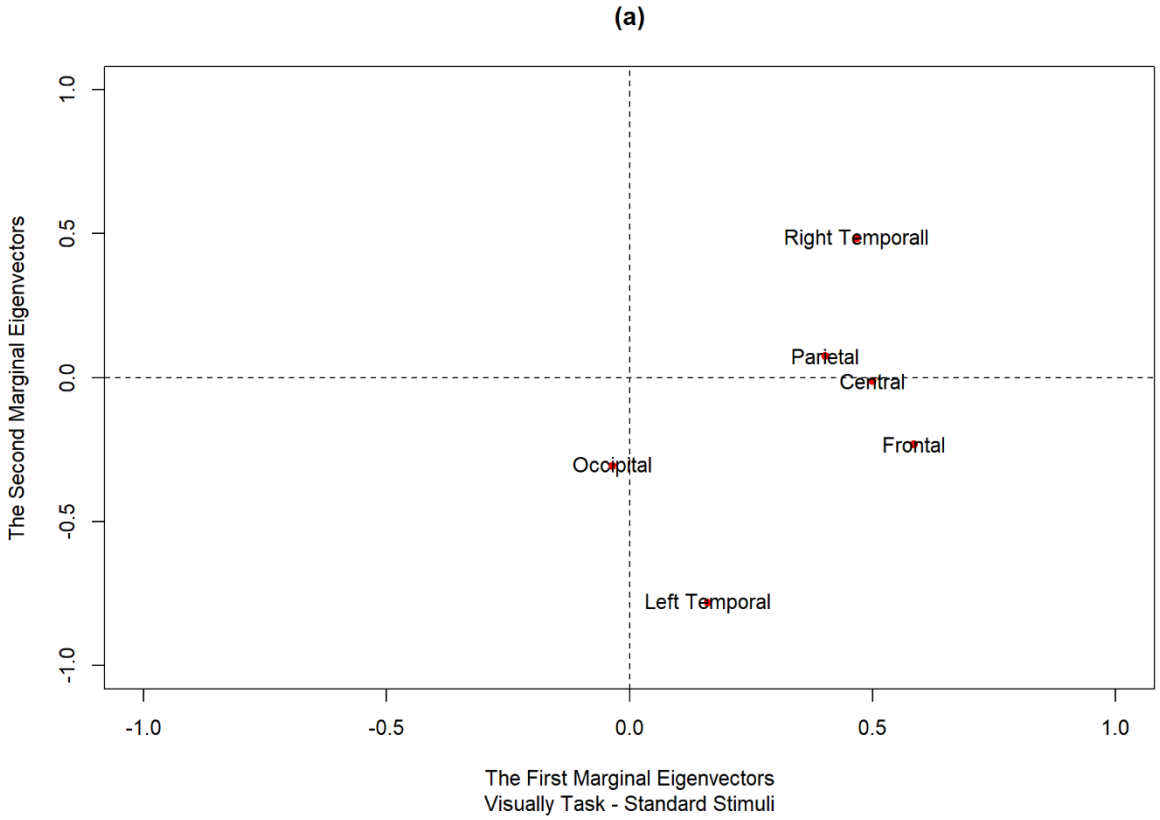



Figure 38. Estimated first and second leading regional marginal eigenvectors.

According to the Figure 37, the first and second marginal principal component analysis (PCA) capture at least nearly 85% of variation in this dimension. The Figure 38 plots estimated first and second leading regional marginal eigenvectors.

*3.1.2. The Reconstructed of the Response .*
The fof regression were conducted group by the number of HPCA and the regions. In the following part, we show the reconstructed ERPs for each subject (in gray) based on the number of HPCA. In this trial, we have 14 HPCA. We also show the point-wise mean and mean ± standard deviation. ( Whole Brain: Figure 39, Frontal region (1): Figure 40, Central Region (2): Figure 41, Occipital Region (3): Figure 42, Parietal Region (4): Figure 43, Left Temporal (5): Figure 44, Right Temporal (6): Figure 45 ).

#### 3.1.2.1 Whole Brain

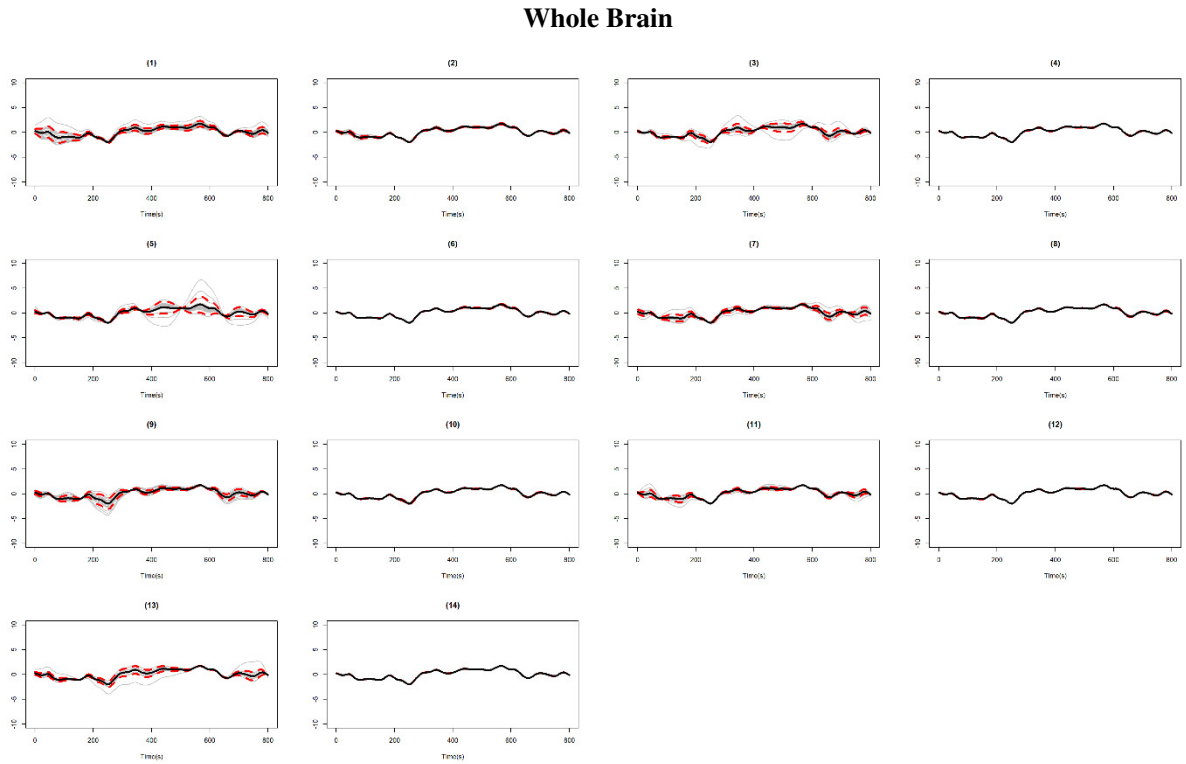



Figure 39. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for whole region of the Brain.

#### 3.1.2.2 Frontal Region (1)

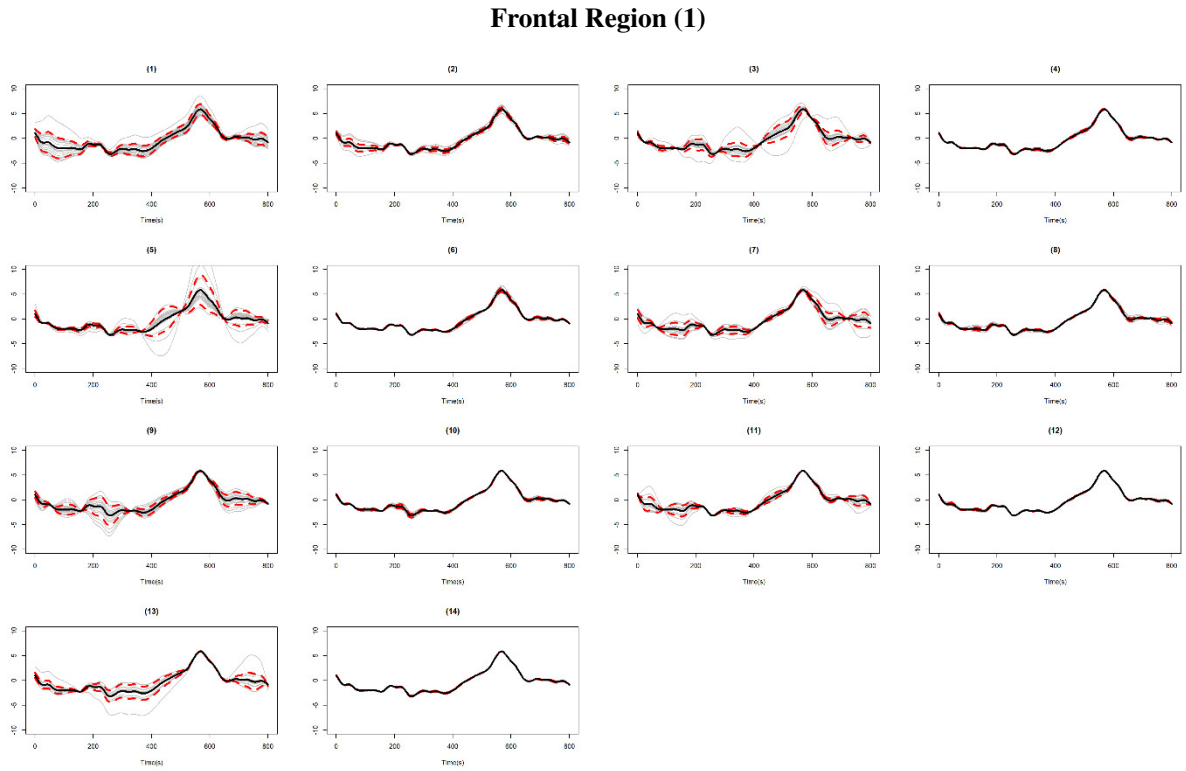



Figure 40. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for frontal region of the Brain.

#### 3.1.2.3 Central Region (2)

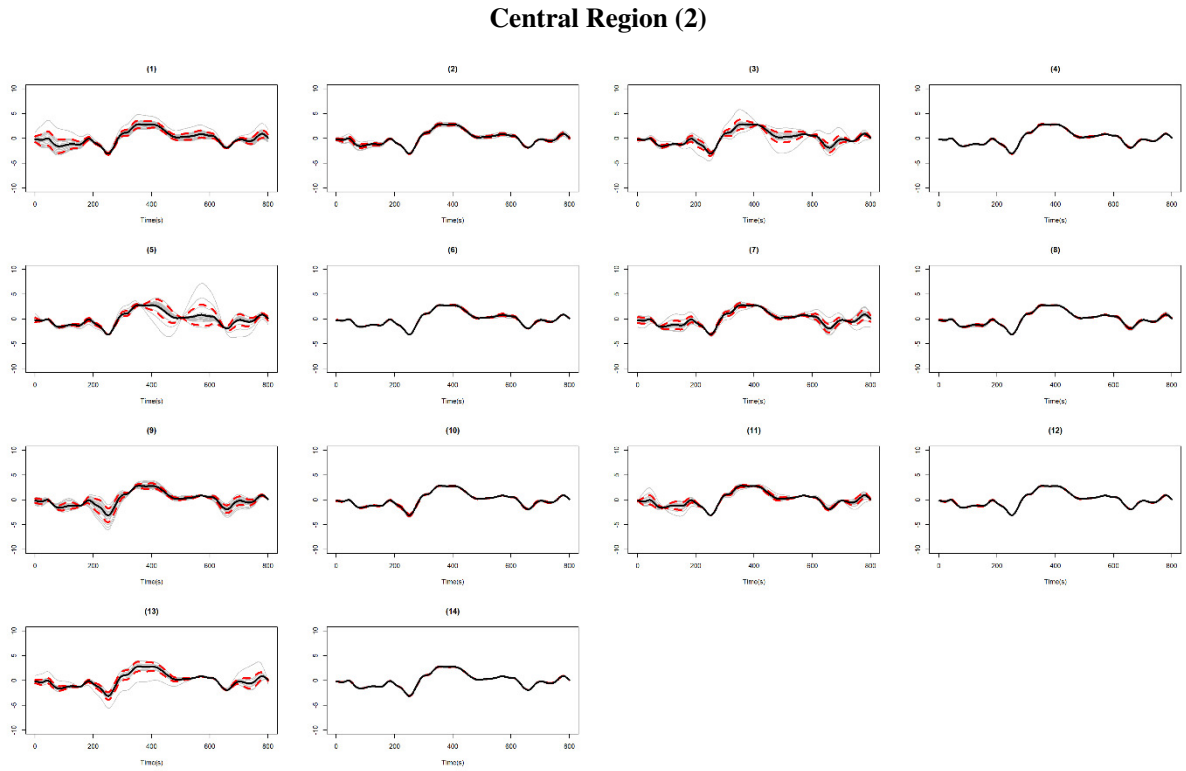



Figure 41. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for central region of the Brain.

#### 3.1.2.4 Occipital Region (3)

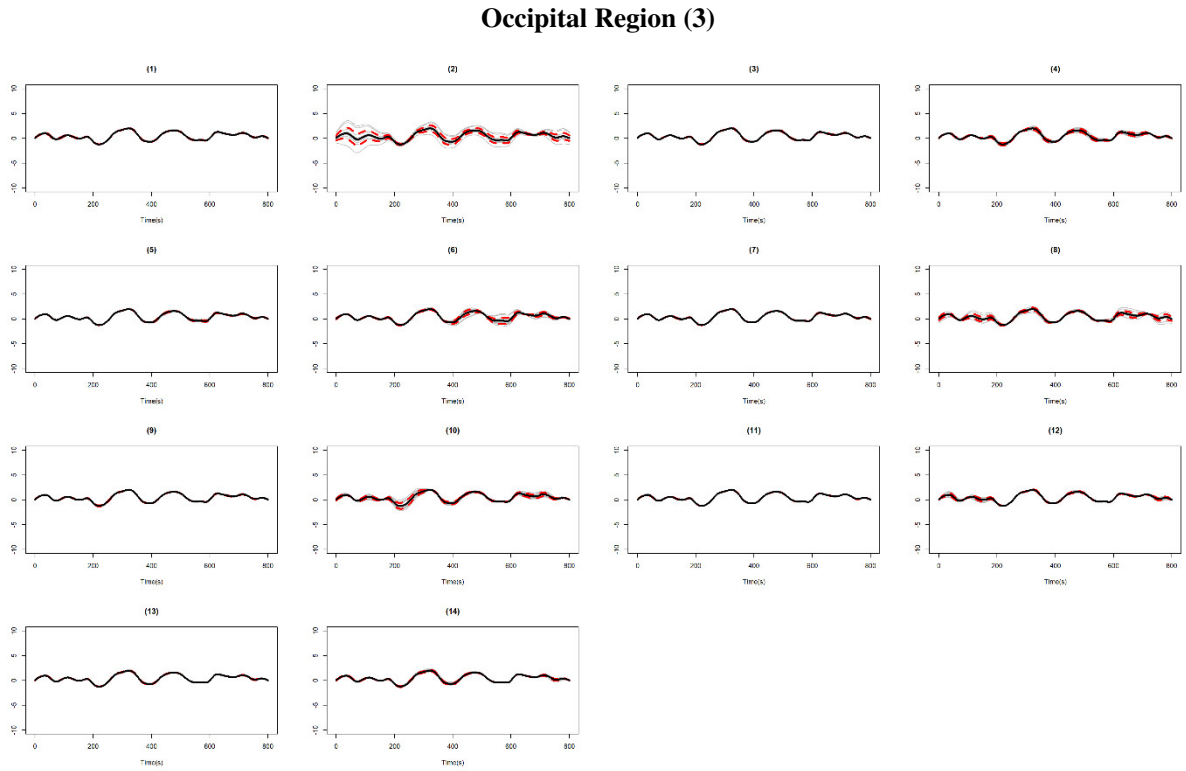



Figure 42. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for occipital region of the Brain.

### 3.1.2.5 Parietal Region (4)

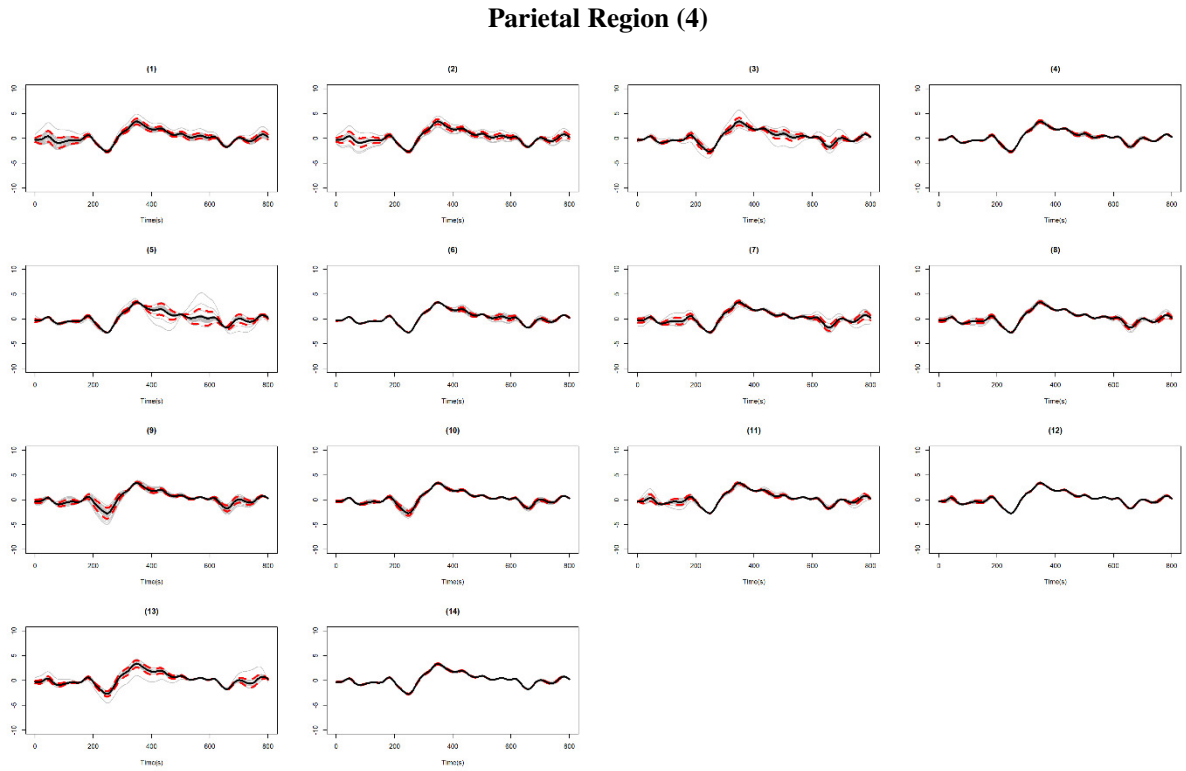



Figure 43. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for parietal region of the Brain.

#### 3.1.2.6 Left Temporal (5)

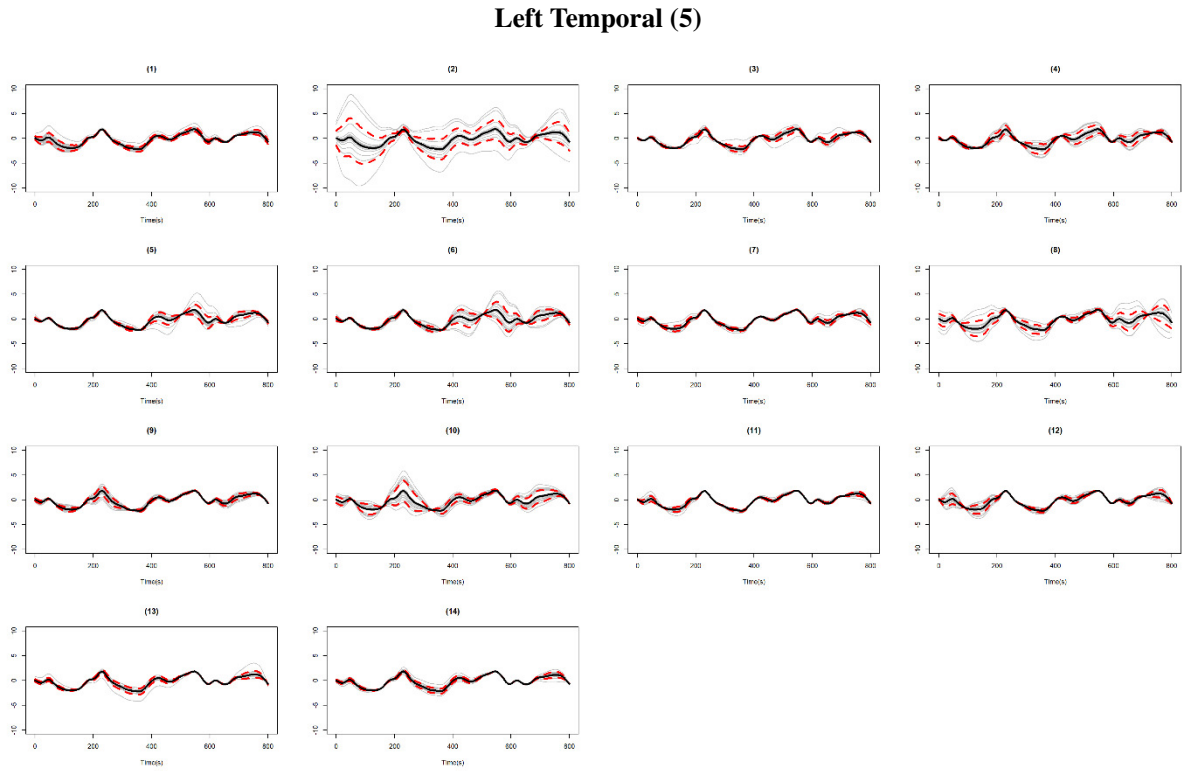



Figure 44. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for left temporal region of the Brain.

#### 3.1.2.7 Right Temporal (6)

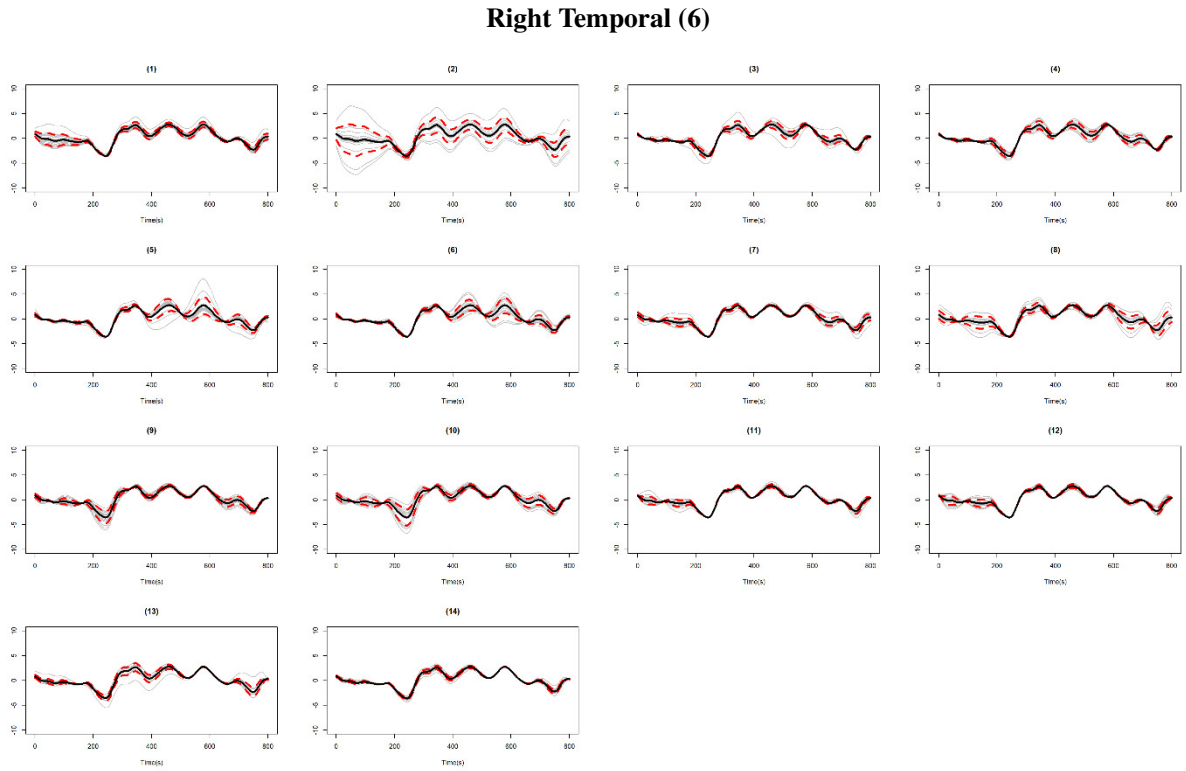



Figure 45. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for right temporal region of the Brain.

*3.1.3. The function-on-function result .*
The fof regression result group by the region of the brain and the number of hybrid principal component analysis (HPCA) were reported.

#### 3.1.3.1 Whole Brain

The MSPE and Correlation group by number of HPCA, Train and Test (Table 43)

The User, System and Elapsed Time group by number of HPCA (Table 44): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 45): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0(0,0.002) | 0.154(0.151,0.154) | 1(0.999,1) | 0.92(0.92,0.922) |
| **2** | 0.002(0.001,0.007) | 0.121(0.117,0.143) | 0.999(0.997,0.999) | 0.938(0.926,0.94) |
| **3** | 0.052(0.052,0.052) | 0.202(0.199,0.29) | 0.974(0.974,0.974) | 0.893(0.844,0.895) |
| **4** | 0.05(0.05,0.05) | 0.305(0.253,0.359) | 0.975(0.975,0.975) | 0.837(0.806,0.865) |
| **5** | 0.106(0.106,0.116) | 0.514(0.512,0.567) | 0.946(0.94,0.946) | 0.711(0.68,0.712) |
| **6** | 0.109(0.102,0.115) | 0.663(0.595,0.663) | 0.944(0.941,0.948) | 0.622(0.622,0.663) |
| **7** | 0.069(0.056,0.104) | 0.716(0.623,0.751) | 0.965(0.946,0.971) | 0.598(0.579,0.655) |
| **8** | 0.113(0.101,0.127) | 0.619(0.573,0.656) | 0.942(0.934,0.948) | 0.643(0.622,0.67) |
| **9** | 0.25(0.242,0.25) | 0.804(0.719,0.804) | 0.866(0.866,0.871) | 0.533(0.533,0.579) |
| **10** | 0.249(0.241,0.25) | 0.795(0.722,0.795) | 0.866(0.866,0.871) | 0.539(0.539,0.59) |
| **11** | 0.274(0.274,0.274) | 0.821(0.77,0.821) | 0.852(0.852,0.852) | 0.519(0.519,0.546) |
| **12** | 0.274(0.259,0.274) | 0.754(0.753,0.819) | 0.852(0.852,0.861) | 0.553(0.519,0.554) |
| **13** | 0.282(0.282,0.353) | 0.784(0.597,0.821) | 0.847(0.804,0.847) | 0.537(0.516,0.648) |
| **14** | 0.28(0.275,0.334) | 0.769(0.627,0.829) | 0.848(0.815,0.851) | 0.534(0.511,0.632) |

Table 43. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 132.735(129.608,137.208) | 0.155(0.13,0.17) | 133.845(129.99,138.443) |
| **2** | 129.18(126.805,136.423) | 0.075(0.037,0.08) | 129.35(127.315,138.178) |
| **3** | 275.04(261.73,283.003) | 0.17(0.105,0.188) | 277.265(266.14,283.955) |
| **4** | 279.52(276.978,283.388) | 0.17(0.145,0.208) | 280.24(277.713,284.248) |
| **5** | 356.87(354.003,358.885) | 0.23(0.22,0.273) | 357.73(355.052,359.998) |
| **6** | 346.875(342.578,348.95) | 0.15(0.14,0.18) | 347.785(343.438,349.96) |
| **7** | 442.385(434.89,452.09) | 0.235(0.16,0.288) | 443.43(435.905,453.085) |
| **8** | 440.895(439.738,448.192) | 0.235(0.175,0.258) | 442.035(440.887,449.04) |
| **9** | 447.46(441.603,453.878) | 0.215(0.2,0.253) | 448.535(442.63,455.027) |
| **10** | 452.43(449.957,456.183) | 0.23(0.205,0.247) | 453.4(450.81,457.12) |
| **11** | 492.1(486.892,494.73) | 0.235(0.195,0.268) | 493.41(487.787,496.688) |
| **12** | 494.22(485.17,498) | 0.24(0.23,0.27) | 495.19(485.887,499.638) |
| **13** | 519.22(514.678,527.563) | 0.18(0.16,0.215) | 519.84(515.342,528.217) |
| **14** | 526.27(518.33,534.045) | 0.245(0.18,0.3) | 526.855(518.963,534.763) |

Table 44. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 1.468(1.141,1.744) | 9(9,9) | 2.5(2,3) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0.01,0.01) | 0(0,0) |
| **2** | 1.218(0.96,1.349) | 10.5(9,11.75) | 2(1.25,3) | 10(0.325,100) | 0.3(0.125,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **3** | 2.705(2.324,3.328) | 9(5,9) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0,0.01) | 0(0,0) |
| **4** | 2.841(2.383,3.361) | 7.5(5,9) | 1(1,1) | 0.1(0.1,0.775) | 0.1(0.1,0.175) | 0.005(0,0.01) | 0(0,0) |
| **5** | 4.426(4.294,4.522) | 9.5(6,10.75) | 1(1,1) | 1(1,7.75) | 0.2(0.2,0.275) | 0.01(0,0.01) | 0(0,0) |
| **6** | 4.499(4.335,4.877) | 11(7.25,11) | 1(1,1) | 10(3.25,10) | 0.3(0.225,0.3) | 0.01(0.003,0.01) | 0(0,0) |
| **7** | 5.141(4.969,5.298) | 11(7.25,11.75) | 3(2.25,4.5) | 10(3.25,77.5) | 0.3(0.225,0.375) | 0.01(0.003,0.01) | 0(0,0) |
| **8** | 5.381(5.299,5.494) | 11(9.5,12) | 2(2,3) | 10(10,100) | 0.3(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **9** | 6.879(6.715,7.202) | 11(11,11) | 1(1,1) | 10(10,77.5) | 0.3(0.3,0.375) | 0.01(0.01,0.01) | 0(0,0) |
| **10** | 6.904(6.446,7.004) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **11** | 7.236(6.851,7.601) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **12** | 7.202(7.122,7.689) | 11.5(11,12) | 1(1,1.75) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **13** | 7.866(7.614,8.175) | 11(11,12) | 1(1,1) | 10(10,100) | 0.3(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **14** | 8.11(7.845,8.289) | 11.5(11,12) | 1(1,1) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |

Table 45. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

#### 3.1.3.2 Frontal Region (1)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 46)

The User, System and Elapsed Time group by number of HPCA (Table 47): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

The Model fitting parameters group by number of HPCA (Table 48): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0(0,0.001) | 0.079(0.077,0.082) | 1(1,1) | 0.96(0.958,0.961) |
| **2** | 0.001(0.001,0.002) | 0.077(0.076,0.09) | 1(0.999,1) | 0.961(0.954,0.961) |
| **3** | 0.028(0.006,0.028) | 0.234(0.229,0.238) | 0.986(0.986,0.997) | 0.876(0.873,0.878) |
| **4** | 0.026(0.026,0.026) | 0.311(0.307,0.311) | 0.987(0.987,0.987) | 0.833(0.833,0.834) |
| **5** | 0.058(0.058,0.064) | 0.307(0.307,0.346) | 0.971(0.967,0.971) | 0.835(0.814,0.835) |
| **6** | 0.058(0.053,0.063) | 0.407(0.369,0.438) | 0.971(0.968,0.973) | 0.779(0.763,0.801) |
| **7** | 0.049(0.047,0.055) | 0.437(0.386,0.451) | 0.975(0.972,0.976) | 0.767(0.756,0.793) |
| **8** | 0.065(0.059,0.072) | 0.454(0.419,0.483) | 0.967(0.963,0.97) | 0.75(0.735,0.768) |
| **9** | 0.171(0.168,0.171) | 0.638(0.616,0.638) | 0.91(0.91,0.912) | 0.647(0.647,0.659) |
| **10** | 0.167(0.155,0.173) | 0.617(0.557,0.632) | 0.912(0.909,0.919) | 0.658(0.649,0.687) |
| **11** | 0.186(0.171,0.189) | 0.637(0.547,0.656) | 0.902(0.9,0.911) | 0.643(0.635,0.694) |
| **12** | 0.181(0.17,0.186) | 0.613(0.571,0.647) | 0.905(0.902,0.911) | 0.662(0.639,0.677) |
| **13** | 0.189(0.181,0.202) | 0.576(0.48,0.639) | 0.9(0.893,0.905) | 0.681(0.642,0.732) |
| **14** | 0.22(0.202,0.243) | 0.577(0.52,0.635) | 0.883(0.87,0.893) | 0.679(0.649,0.71) |

Table 46. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for frontal region brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 166.085(164.56,167.723) | 0.125(0.093,0.22) | 166.365(164.805,168.063) |
| **2** | 167.16(163.678,169.053) | 0.09(0.08,0.11) | 167.42(164.305,169.347) |
| **3** | 274.84(269.237,280.23) | 0.12(0.103,0.365) | 275.13(269.59,280.962) |
| **4** | 277.455(273.77,279.71) | 0.11(0.075,0.147) | 277.815(274.035,280.075) |
| **5** | 343.7(339.947,346.453) | 0.145(0.112,0.188) | 344.12(340.29,346.872) |
| **6** | 338.175(335.905,343.098) | 0.135(0.112,0.195) | 338.675(336.355,343.65) |
| **7** | 401.455(393.633,409.298) | 0.17(0.16,0.188) | 402.095(394.068,409.857) |
| **8** | 399.575(395.168,402.768) | 0.195(0.17,0.238) | 400.25(395.653,403.48) |
| **9** | 438.85(431.328,453.083) | 0.275(0.188,0.362) | 439.475(432.115,453.77) |
| **10** | 439.19(436.31,441.21) | 0.25(0.188,0.27) | 440.385(438.233,442.22) |
| **11** | 477.085(472.262,490.36) | 0.195(0.163,0.243) | 478.12(475.555,491.237) |
| **12** | 468.9(465.2,471.443) | 0.225(0.192,0.325) | 470.45(466.73,472.423) |
| **13** | 488.875(480.19,491.64) | 0.19(0.17,0.205) | 489.73(480.883,492.357) |
| **14** | 486.085(478.745,494.245) | 0.195(0.157,0.22) | 486.865(479.295,495.055) |

Table 47. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.731(0.705,0.85) | 9(6,9) | 3(1,3) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0.003,0.01) | 0(0,0) |
| **2** | 0.54(0.459,0.582) | 9(9,11) | 2(1,2) | 10(0.1,77.5) | 0.3(0.1,0.375) | 0.01(0.01,0.01) | 0(0,0) |
| **3** | 2.399(2.192,2.865) | 5(5,5) | 1(1,2) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **4** | 2.09(1.981,2.662) | 5(5,5) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **5** | 2.776(2.563,2.918) | 6(6,9.75) | 1(1,1) | 1(1,7.75) | 0.2(0.2,0.275) | 0(0,0.008) | 0(0,0) |
| **6** | 2.478(2.191,2.9) | 11(6.75,11) | 1(1,1) | 10(1,10) | 0.3(0.2,0.3) | 0.01(0.003,0.01) | 0(0,0) |
| **7** | 3.223(3.098,3.377) | 11(7,11.75) | 2(2,3.75) | 10(1,77.5) | 0.3(0.2,0.375) | 0.01(0.003,0.01) | 0(0,0) |
| **8** | 3.064(2.823,3.314) | 11(9.5,11.75) | 2(2,2.75) | 10(10,100) | 0.3(0.3,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **9** | 4.563(4.456,4.623) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **10** | 4.726(4.524,4.888) | 9(4.75,11) | 1(1,1.75) | 10(10,100) | 0.3(0.3,0.4) | 0.005(0,0.01) | 0(0,0) |
| **11** | 5.222(5.025,5.397) | 11.5(8,12) | 1(1,1.75) | 55(10,100) | 0.35(0.3,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **12** | 5.112(4.989,5.26) | 8(3.25,9.75) | 1(1,1.75) | 10(3.25,100) | 0.3(0.225,0.4) | 0(0,0.01) | 0(0,0) |
| **13** | 5.291(5.243,5.412) | 8.5(5,11) | 1(1,1.75) | 55(3.25,100) | 0.35(0.225,0.4) | 0.005(0,0.01) | 0(0,0) |
| **14** | 5.273(5.063,5.521) | 11.5(11,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0.01,0.01) | 0(0,0) |

Table 48. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

#### 3.1.3.3 Central Region (2)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 49)

The User, System and Elapsed Time group by number of HPCA (Table 50): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 51): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.001(0,0.001) | 0.092(0.089,0.092) | 1(1,1) | 0.953(0.953,0.955) |
| **2** | 0(0,0) | 0.141(0.124,0.145) | 1(1,1) | 0.929(0.926,0.937) |
| **3** | 0.048(0.048,0.048) | 0.233(0.196,0.233) | 0.975(0.975,0.975) | 0.877(0.877,0.897) |
| **4** | 0.051(0.051,0.051) | 0.121(0.121,0.162) | 0.974(0.974,0.974) | 0.937(0.915,0.937) |
| **5** | 0.086(0.049,0.086) | 0.4(0.38,0.417) | 0.956(0.956,0.975) | 0.781(0.771,0.793) |
| **6** | 0.092(0.09,0.101) | 0.359(0.348,0.366) | 0.953(0.948,0.954) | 0.802(0.799,0.81) |
| **7** | 0.068(0.057,0.143) | 0.46(0.432,0.483) | 0.965(0.926,0.971) | 0.745(0.729,0.762) |
| **8** | 0.155(0.147,0.155) | 0.41(0.41,0.415) | 0.919(0.919,0.924) | 0.77(0.77,0.77) |
| **9** | 0.191(0.191,0.191) | 0.489(0.489,0.489) | 0.899(0.899,0.899) | 0.726(0.726,0.726) |
| **10** | 0.192(0.192,0.192) | 0.509(0.509,0.509) | 0.899(0.899,0.899) | 0.713(0.713,0.713) |
| **11** | 0.208(0.208,0.208) | 0.598(0.597,0.598) | 0.89(0.89,0.89) | 0.661(0.661,0.661) |
| **12** | 0.209(0.2,0.209) | 0.601(0.601,0.644) | 0.889(0.889,0.894) | 0.66(0.64,0.66) |
| **13** | 0.216(0.213,0.275) | 0.567(0.445,0.586) | 0.885(0.851,0.887) | 0.677(0.667,0.748) |
| **14** | 0.218(0.215,0.218) | 0.562(0.545,0.58) | 0.884(0.884,0.886) | 0.68(0.67,0.689) |

Table 49. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 162.555(160.223,164.527) | 0.12(0.095,0.175) | 162.87(160.62,164.865) |
| **2** | 163.9(162.222,165.41) | 0.075(0.045,0.115) | 164.14(162.355,165.612) |
| **3** | 275.92(273.293,278.887) | 0.13(0.095,0.155) | 276.385(273.51,279.178) |
| **4** | 278.11(271.488,283.51) | 0.155(0.115,0.21) | 278.825(271.795,284.1) |
| **5** | 354.905(352.413,358.658) | 0.175(0.118,0.215) | 355.835(353.87,359.615) |
| **6** | 356.675(351.792,359.213) | 0.21(0.157,0.22) | 357.32(352.435,359.88) |
| **7** | 443.325(436.328,451.31) | 0.16(0.15,0.168) | 443.78(436.838,451.868) |
| **8** | 436.39(428.53,438.917) | 0.205(0.143,0.3) | 436.855(429.007,439.357) |
| **9** | 506.645(500.028,512.225) | 0.2(0.153,0.245) | 507.29(500.59,512.75) |
| **10** | 515.82(507.658,525.483) | 0.21(0.16,0.265) | 516.505(508.327,525.87) |
| **11** | 507.61(500.242,515.095) | 0.205(0.173,0.23) | 508.17(500.915,515.702) |
| **12** | 500.73(497.435,502.777) | 0.17(0.16,0.198) | 501.185(497.878,503.408) |
| **13** | 537.455(530.072,541.39) | 0.2(0.162,0.28) | 538.275(530.612,542.215) |
| **14** | 542.41(536.01,549.055) | 0.23(0.17,0.397) | 543.1(536.728,549.872) |

Table 50. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for central region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.882(0.804,1.046) | 9(9,9) | 2(1,3) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0.01,0.01) | 0(0,0) |
| **2** | 1.147(1.084,1.225) | 9(2,9) | 3(2,3) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0,0.01) | 0(0,0) |
| **3** | 2.256(2.085,2.488) | 5(5,8) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0.008) | 0(0,0) |
| **4** | 2.287(1.93,2.425) | 9(6,9) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0.003,0.01) | 0(0,0) |
| **5** | 4.14(4.074,4.318) | 6(5.25,9.75) | 1(1,1.75) | 1(0.325,1) | 0.2(0.125,0.2) | 0(0,0.01) | 0(0,0) |
| **6** | 4.149(3.875,4.279) | 8.5(6,11) | 1(1,1) | 10(1,10) | 0.3(0.2,0.3) | 0.005(0,0.01) | 0(0,0) |
| **7** | 5.158(4.975,5.377) | 10.5(6,11) | 2.5(1,3) | 5.5(1,10) | 0.25(0.2,0.3) | 0.01(0,0.01) | 0(0,0) |
| **8** | 5.275(5.139,5.623) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **9** | 5.827(5.635,5.986) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **10** | 5.623(5.605,5.778) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **11** | 6.109(5.937,6.243) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **12** | 6.121(5.991,6.344) | 11(10.25,11) | 1(1,1) | 10(3.25,10) | 0.3(0.225,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **13** | 6.921(6.576,7.054) | 11(8,11.75) | 1(1,1) | 10(10,77.5) | 0.3(0.3,0.375) | 0.01(0.003,0.01) | 0(0,0) |
| **14** | 6.748(6.51,6.934) | 11(8,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.003,0.01) | 0(0,0) |

Table 51. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for central region of the brain.

#### 3.1.3.4 Occipital Region (3)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 52)

The User, System and Elapsed Time group by number of HPCA (Table 53): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 54): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0(0,0) | 0.002(0.002,0.002) | 1(1,1) | 0.999(0.999,0.999) |
| **2** | 0.002(0.001,0.002) | 0.322(0.322,0.326) | 0.999(0.999,1) | 0.836(0.836,0.837) |
| **3** | 0.004(0.004,0.004) | 0.326(0.326,0.326) | 0.998(0.998,0.998) | 0.834(0.834,0.835) |
| **4** | 0.001(0,0.032) | 0.638(0.544,0.647) | 0.999(0.984,1) | 0.683(0.677,0.717) |
| **5** | 0.007(0,0.007) | 0.659(0.651,0.663) | 0.997(0.997,1) | 0.667(0.665,0.675) |
| **6** | 0.072(0.072,0.072) | 0.563(0.563,0.563) | 0.963(0.963,0.963) | 0.698(0.698,0.698) |
| **7** | 0.001(0,0.055) | 0.759(0.619,0.759) | 1(0.972,1) | 0.605(0.605,0.669) |
| **8** | 0.05(0.006,0.095) | 0.628(0.55,0.706) | 0.974(0.951,0.997) | 0.663(0.631,0.695) |
| **9** | 0.1(0.019,0.1) | 0.638(0.549,0.711) | 0.948(0.948,0.99) | 0.648(0.623,0.696) |
| **10** | 0.224(0.147,0.224) | 0.742(0.655,0.742) | 0.881(0.881,0.923) | 0.586(0.586,0.638) |
| **11** | 0.22(0.148,0.224) | 0.736(0.622,0.739) | 0.883(0.88,0.923) | 0.588(0.587,0.651) |
| **12** | 0.229(0.222,0.229) | 0.787(0.785,0.787) | 0.878(0.878,0.882) | 0.559(0.559,0.56) |
| **13** | 0.228(0.139,0.232) | 0.789(0.656,0.791) | 0.879(0.876,0.928) | 0.557(0.556,0.63) |
| **14** | 0.24(0.237,0.24) | 0.787(0.787,0.789) | 0.872(0.872,0.873) | 0.555(0.554,0.555) |

Table 52. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 129.64(128.415,130.41) | 0.1(0.058,0.125) | 129.81(128.705,130.555) |
| **2** | 175.47(173.245,178.508) | 0.09(0.042,0.118) | 175.855(173.44,178.717) |
| **3** | 241.895(237.55,246.548) | 0.095(0.082,0.125) | 242.25(237.877,246.823) |
| **4** | 283.435(277.077,286.468) | 0.135(0.095,0.165) | 283.74(277.515,286.76) |
| **5** | 335.115(326.84,339.542) | 0.125(0.088,0.177) | 335.59(327.575,340.162) |
| **6** | 372.7(360.67,377.63) | 0.175(0.162,0.19) | 373.26(361.44,378.335) |
| **7** | 352.57(348.503,355.042) | 0.185(0.14,0.205) | 352.965(348.925,355.487) |
| **8** | 418.205(412.29,427.415) | 0.165(0.12,0.193) | 418.81(412.86,428.153) |
| **9** | 405.76(400.345,410.537) | 0.14(0.117,0.185) | 406.33(400.82,411.18) |
| **10** | 497.015(493.42,500.673) | 0.17(0.132,0.218) | 497.745(494.16,501.418) |
| **11** | 470.325(461.04,477.205) | 0.215(0.2,0.265) | 470.995(461.877,477.938) |
| **12** | 571.86(557.247,579.693) | 0.245(0.23,0.307) | 572.5(557.992,581.095) |
| **13** | 539.38(532.263,550.772) | 0.2(0.172,0.22) | 539.97(532.902,551.52) |
| **14** | not calculated | not calculated | not calculated |

Table 53. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.017(0.015,0.021) | 9(9,10.5) | 2(1,3.75) | 0.1(0.1,77.5) | 0.1(0.1,0.375) | 0.01(0.01,0.01) | 0(0,0) |
| **2** | 1.346(1.228,1.416) | 1(1,1) | 1(1,2.5) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **3** | 1.292(1.14,1.422) | 1(1,1.75) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **4** | 1.807(1.593,1.856) | 2(2,3) | 3(1,4) | 1(1,10) | 0.2(0.2,0.3) | 0(0,0) | 0(0,0) |
| **5** | 1.716(1.524,1.932) | 1.5(1,2) | 3.5(2,5) | 0.55(0.1,1) | 0.15(0.1,0.2) | 0(0,0) | 0(0,0) |
| **6** | 2.853(2.71,3.36) | 9(9,9) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0.01,0.01) | 0(0,0) |
| **7** | 2.928(2.75,3.142) | 1(1,1) | 4(1.75,4.75) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **8** | 5.398(5.252,6.001) | 1(1,1) | 2.5(1,4) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **9** | 5.361(5.045,5.489) | 1(1,1) | 1(1,3.5) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **10** | 5.22(5.144,5.442) | 12(5.25,12) | 1(1,1) | 100(25.075,100) | 0.4(0.175,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **11** | 5.222(5.002,5.583) | 8(1.75,12) | 1(1,1) | 100(25.075,100) | 0.4(0.175,0.4) | 0.005(0,0.01) | 0(0,0) |
| **12** | 5.535(5.387,5.828) | 12(5,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |
| **13** | 5.689(5.339,6.061) | 10.5(1.75,12) | 1(1,1) | 100(0.1,100) | 0.4(0.1,0.4) | 0.01(0,0.01) | 0(0,0) |
| **14** | 5.981(5.911,6.086) | 12(8,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |

Table 54. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

#### 3.1.3.5 Parietal (4)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 55)

The User, System and Elapsed Time group by number of HPCA (Table 56): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 57): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0(0,0) | 0.062(0.062,0.062) | 1(1,1) | 0.968(0.968,0.969) |
| **2** | 0(0,0) | 0.218(0.158,0.28) | 1(1,1) | 0.89(0.86,0.919) |
| **3** | 0.052(0.052,0.052) | 0.293(0.292,0.293) | 0.974(0.974,0.974) | 0.847(0.847,0.847) |
| **4** | 0.065(0.021,0.066) | 0.152(0.121,0.295) | 0.967(0.967,0.99) | 0.922(0.854,0.938) |
| **5** | 0.096(0.096,0.096) | 0.295(0.275,0.321) | 0.951(0.951,0.951) | 0.841(0.826,0.852) |
| **6** | 0.107(0.107,0.117) | 0.212(0.177,0.255) | 0.945(0.939,0.945) | 0.888(0.863,0.909) |
| **7** | 0.156(0.105,0.162) | 0.296(0.264,0.451) | 0.919(0.915,0.946) | 0.839(0.755,0.858) |
| **8** | 0.176(0.176,0.176) | 0.236(0.236,0.236) | 0.908(0.908,0.908) | 0.875(0.875,0.875) |
| **9** | 0.192(0.192,0.192) | 0.263(0.263,0.263) | 0.899(0.899,0.899) | 0.858(0.858,0.858) |
| **10** | 0.195(0.192,0.195) | 0.343(0.343,0.343) | 0.897(0.897,0.899) | 0.811(0.811,0.811) |
| **11** | 0.209(0.205,0.209) | 0.416(0.416,0.416) | 0.889(0.889,0.891) | 0.767(0.767,0.767) |
| **12** | 0.21(0.206,0.21) | 0.408(0.386,0.412) | 0.889(0.888,0.891) | 0.772(0.77,0.784) |
| **13** | 0.217(0.215,0.258) | 0.383(0.354,0.384) | 0.885(0.861,0.886) | 0.786(0.786,0.804) |
| **14** | 0.223(0.217,0.223) | 0.378(0.358,0.378) | 0.881(0.881,0.885) | 0.79(0.79,0.801) |

Table 55. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 166.93(165.84,168.605) | 0.09(0.09,0.122) | 167.61(166.298,169.408) |
| **2** | 186.96(185.335,191.493) | 0.14(0.088,0.19) | 187.505(186.075,192.173) |
| **3** | 305.285(301.555,306.425) | 0.15(0.13,0.218) | 306.18(302.185,307.85) |
| **4** | 308.05(305.672,314.672) | 0.13(0.095,0.17) | 308.745(306.16,314.965) |
| **5** | 362.675(358.795,366.98) | 0.18(0.145,0.22) | 363.43(359.375,367.575) |
| **6** | 377.175(369.793,383.8) | 0.17(0.135,0.215) | 377.74(370.928,384.35) |
| **7** | 456.545(412.535,462.275) | 0.205(0.175,0.238) | 457.14(413.547,463.5) |
| **8** | 387.355(382.09,389.03) | 0.175(0.123,0.19) | 387.86(382.545,389.725) |
| **9** | 428.75(423.345,432.682) | 0.18(0.163,0.197) | 429.17(423.718,433.07) |
| **10** | 437.535(434.617,444.57) | 0.215(0.153,0.247) | 437.885(435.063,445.193) |
| **11** | 494.575(490.223,503.015) | 0.2(0.14,0.303) | 495.11(490.58,503.48) |
| **12** | 440.58(436.94,447.995) | 0.13(0.065,0.185) | 440.97(437.268,448.352) |
| **13** | 462.525(456.09,470.052) | 0.175(0.13,0.215) | 463.28(456.415,470.478) |
| **14** | 472.345(470.677,475.735) | 0.22(0.197,0.243) | 472.82(471.042,476.163) |

Table 56. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.591(0.45,0.645) | 9(9,9) | 3(3,3) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0.01,0.01) | 0(0,0) |
| **2** | 1.625(1.354,1.72) | 5(1,9) | 3(3,3) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.005(0,0.01) | 0(0,0) |
| **3** | 2.124(2.022,2.447) | 9(9,9) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0.01,0.01) | 0(0,0) |
| **4** | 2.436(2.341,2.624) | 9(9,10) | 1(1,1.75) | 0.1(0.1,1) | 0.1(0.1,0.2) | 0.01(0.01,0.01) | 0(0,0) |
| **5** | 4.195(3.929,4.427) | 7(6,9) | 1(1,1) | 1(0.1,1) | 0.2(0.1,0.2) | 0(0,0.01) | 0(0,0) |
| **6** | 3.862(3.699,4.218) | 9(6.25,11) | 1(1,1) | 5.5(0.325,10) | 0.25(0.125,0.3) | 0.01(0,0.01) | 0(0,0) |
| **7** | 4.894(4.821,5.035) | 10.5(7.25,11) | 1(1,2) | 10(3.25,10) | 0.3(0.225,0.3) | 0.01(0,0.01) | 0(0,0) |
| **8** | 4.929(4.665,5.188) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **9** | 5.124(4.999,5.286) | 11(11,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.01,0.01) | 0(0,0) |
| **10** | 5.329(5.133,5.71) | 11(7.75,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.003,0.01) | 0(0,0) |
| **11** | 5.449(5.17,5.716) | 11(5,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.003,0.01) | 0(0,0) |
| **12** | 5.513(5.403,5.604) | 11(7.5,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.01(0.003,0.01) | 0(0,0) |
| **13** | 6.351(5.922,6.701) | 11(7.25,11) | 1(1,1) | 10(10,77.5) | 0.3(0.3,0.375) | 0.01(0,0.01) | 0(0,0) |
| **14** | 6.291(6.215,6.352) | 9.5(6.25,11) | 1(1,1) | 10(10,10) | 0.3(0.3,0.3) | 0.005(0,0.01) | 0(0,0) |

Table 57. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

#### 3.1.3.6 Left Temporal (5)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 58)

The User, System and Elapsed Time group by number of HPCA (Table 59): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 60): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.001(0,0.001) | 0.052(0.05,0.059) | 1(1,1) | 0.974(0.97,0.975) |
| **2** | 0.013(0.013,0.013) | 0.653(0.653,0.653) | 0.993(0.993,0.993) | 0.657(0.657,0.657) |
| **3** | 0.087(0.087,0.087) | 0.698(0.698,0.703) | 0.955(0.955,0.955) | 0.613(0.606,0.613) |
| **4** | 0.127(0.041,0.127) | 0.841(0.831,1.111) | 0.934(0.934,0.979) | 0.514(0.406,0.523) |
| **5** | 0.216(0.086,0.216) | 0.841(0.841,1.105) | 0.885(0.885,0.955) | 0.484(0.348,0.485) |
| **6** | 0.185(0.018,0.278) | 0.962(0.952,1.194) | 0.901(0.849,0.991) | 0.367(0.258,0.38) |
| **7** | 0.006(0.001,0.122) | 1.177(0.935,1.185) | 0.997(0.937,1) | 0.268(0.264,0.389) |
| **8** | 0.026(0.026,0.122) | 1.139(1.128,1.14) | 0.987(0.936,0.987) | 0.258(0.257,0.261) |
| **9** | 0.349(0.213,0.756) | 0.969(0.862,1.06) | 0.806(0.447,0.886) | 0.259(0.202,0.418) |
| **10** | 0.36(0.36,0.36) | 0.853(0.793,0.947) | 0.8(0.8,0.8) | 0.425(0.352,0.469) |
| **11** | 0.718(0.372,0.902) | 0.93(0.917,0.991) | 0.507(0.311,0.792) | 0.272(0.261,0.37) |
| **12** | 0.39(0.39,0.768) | 0.968(0.888,0.97) | 0.781(0.439,0.781) | 0.333(0.219,0.389) |
| **13** | 0.408(0.408,0.872) | 0.963(0.845,1.001) | 0.769(0.355,0.769) | 0.329(0.168,0.42) |
| **14** | 0.425(0.425,0.425) | 1.036(0.886,1.059) | 0.758(0.758,0.758) | 0.275(0.128,0.384) |

Table 58. - The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 135.275(133.348,136.925) | 0.1(0.068,0.125) | 135.49(133.415,137.345) |
| **2** | 170.325(169.16,173.732) | 0.085(0.055,0.145) | 170.455(169.347,175.115) |
| **3** | 228.65(227.853,231.705) | 0.115(0.09,0.16) | 229.24(228.117,232.06) |
| **4** | 252.56(250.083,254.155) | 0.11(0.078,0.263) | 252.9(250.3,254.41) |
| **5** | 327.765(321.878,334.377) | 0.12(0.09,0.13) | 328.09(322.153,334.64) |
| **6** | 333.8(327.013,334.78) | 0.135(0.113,0.15) | 334.08(327.37,335.1) |
| **7** | 369.76(368.825,371.26) | 0.13(0.12,0.14) | 370.08(369.095,371.635) |
| **8** | 383.12(379.718,388.095) | 0.135(0.113,0.148) | 383.52(380.072,388.362) |
| **9** | 368.225(365.783,372.327) | 0.15(0.12,0.17) | 368.595(366.083,372.698) |
| **10** | 440.295(434.132,449.418) | 0.19(0.147,0.208) | 440.685(434.632,449.998) |
| **11** | 423.33(421.53,433.58) | 0.175(0.145,0.197) | 423.66(421.86,434.078) |
| **12** | 491.27(488.068,501.69) | 0.17(0.147,0.218) | 491.68(488.525,502.177) |
| **13** | 473.115(470.413,480.36) | 0.205(0.19,0.25) | 473.55(470.75,480.76) |
| **14** | 478.865(469.862,484.09) | 0.15(0.14,0.22) | 479.44(470.245,484.76) |

Table 59. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.55(0.508,0.641) | 9(8,9) | 1(1,3) | 0.1(0.1,75.025) | 0.1(0.1,0.325) | 0.01(0,0.01) | 0(0,0) |
| **2** | 3.326(3.138,3.519) | 2(2,2) | 1(1,1) | 1(1,1) | 0.2(0.2,0.2) | 0(0,0) | 0(0,0) |
| **3** | 4.716(4.349,5.151) | 2(2,2) | 1(1,1) | 1(1,1) | 0.2(0.2,0.2) | 0(0,0) | 0(0,0) |
| **4** | 5.775(5.277,6.333) | 1.5(1,2) | 1(1,1.75) | 0.55(0.1,1) | 0.15(0.1,0.2) | 0(0,0) | 0(0,0) |
| **5** | 7.017(6.789,7.296) | 2(2,3) | 1(1,2.5) | 1(1,10) | 0.2(0.2,0.3) | 0(0,0) | 0(0,0) |
| **6** | 9.47(9.174,9.885) | 3(1.25,5) | 1.5(1,4.5) | 0.1(0.1,0.775) | 0.1(0.1,0.175) | 0(0,0) | 0(0,0) |
| **7** | 9.356(8.903,9.871) | 1(1,2.75) | 5.5(2,6) | 0.1(0.1,0.775) | 0.1(0.1,0.175) | 0(0,0) | 0(0,0) |
| **8** | 12.046(11.794,12.189) | 1(1,1) | 4(4,4) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **9** | 12.465(11.742,12.926) | 1(1,1) | 2(1,3.5) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,75) |
| **10** | 11.09(10.846,12.297) | 1(1,8) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0.008) | 0(0,0) |
| **11** | 12.491(11.899,12.73) | 8.5(3.5,9.75) | 1.5(1,2) | 0.55(0.1,7.75) | 0.15(0.1,0.275) | 0.005(0,0.01) | 50(0,100) |
| **12** | 12.352(11.812,12.904) | 4.5(1,9) | 1(1,2.5) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0.01) | 0(0,75) |
| **13** | 12.693(12.128,12.918) | 1.5(1,4) | 1(1,6.75) | 0.1(0.1,0.775) | 0.1(0.1,0.175) | 0(0,0) | 0(0,75.25) |
| **14** | 12.482(11.919,12.914) | 1(1,9) | 1(1,3.25) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0.01) | 0(0,0) |

Table 60. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

#### 3.1.3.7 Right Temporal (6)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 61)

The User, System and Elapsed Time group by number of HPCA (Table 62): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 63): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | **MSPE** | | **Correlation** | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0(0,0) | 0.051(0.05,0.051) | 1(1,1) | 0.974(0.974,0.975) |
| **2** | 0.004(0,0.008) | 0.612(0.367,0.863) | 0.998(0.996,1) | 0.701(0.584,0.814) |
| **3** | 0.057(0.057,0.057) | 0.716(0.491,0.943) | 0.971(0.971,0.971) | 0.637(0.531,0.743) |
| **4** | 0.179(0.037,0.183) | 0.378(0.378,0.476) | 0.906(0.904,0.981) | 0.797(0.751,0.797) |
| **5** | 0.052(0.014,0.14) | 0.62(0.449,1.007) | 0.973(0.927,0.993) | 0.658(0.468,0.753) |
| **6** | 0.208(0.092,0.264) | 0.438(0.434,0.474) | 0.89(0.858,0.953) | 0.757(0.752,0.759) |
| **7** | 0.245(0.104,0.281) | 0.498(0.462,0.534) | 0.869(0.848,0.947) | 0.717(0.694,0.745) |
| **8** | 0.34(0.339,0.34) | 0.491(0.49,0.491) | 0.812(0.812,0.813) | 0.72(0.72,0.721) |
| **9** | 0.348(0.348,0.348) | 0.451(0.451,0.451) | 0.807(0.807,0.807) | 0.744(0.744,0.744) |
| **10** | 0.372(0.372,0.372) | 0.604(0.604,0.604) | 0.792(0.792,0.792) | 0.644(0.644,0.644) |
| **11** | 0.377(0.377,0.377) | 0.624(0.624,0.625) | 0.789(0.789,0.789) | 0.629(0.629,0.629) |
| **12** | 0.39(0.39,0.39) | 0.607(0.607,0.608) | 0.781(0.781,0.781) | 0.639(0.638,0.639) |
| **13** | 0.41(0.41,0.41) | 0.576(0.576,0.576) | 0.768(0.768,0.768) | 0.657(0.657,0.657) |
| **14** | 0.411(0.411,0.411) | 0.626(0.626,0.626) | 0.767(0.767,0.767) | 0.627(0.627,0.627) |

Table 61. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

| HPCA | **Time (s)** | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 134.655(133.883,135.99) | 0.055(0.05,0.083) | 134.765(134.035,136.087) |
| **2** | 162.19(159.59,163.907) | 0.075(0.063,0.11) | 162.345(159.685,164.372) |
| **3** | 246.31(242.053,250.637) | 0.125(0.073,0.148) | 246.55(242.32,250.93) |
| **4** | 261.48(255.098,266.955) | 0.105(0.085,0.185) | 261.845(255.382,267.31) |
| **5** | 337.975(335.01,341.485) | 0.145(0.133,0.157) | 338.405(335.375,341.86) |
| **6** | 377.94(374.205,383.617) | 0.12(0.087,0.16) | 378.23(374.632,384.005) |
| **7** | 426.21(416.545,430.733) | 0.135(0.112,0.198) | 426.79(416.918,431.165) |
| **8** | 395.57(389.53,399.938) | 0.16(0.12,0.205) | 396.005(389.818,400.46) |
| **9** | 422.66(416.485,425.012) | 0.175(0.125,0.21) | 423.02(416.872,425.427) |
| **10** | 439.865(434.787,446.15) | 0.165(0.118,0.193) | 440.275(435.172,446.623) |
| **11** | 491.8(487.195,495.978) | 0.17(0.143,0.23) | 492.225(487.715,496.43) |
| **12** | 441.275(434.273,446.172) | 0.18(0.113,0.208) | 441.705(434.72,446.542) |
| **13** | 463.785(459.97,470.732) | 0.14(0.12,0.185) | 464.235(460.348,471.085) |
| **14** | 480.595(473.235,483.88) | 0.18(0.12,0.223) | 481.07(473.688,485.953) |

Table 62. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.455(0.386,0.494) | 9(9,9) | 2.5(2,3) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0.01,0.01) | 0(0,0) |
| **2** | 3.141(2.705,3.767) | 5(1,9) | 1.5(1,2.75) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.005(0,0.01) | 0(0,0) |
| **3** | 3.948(3.611,4.378) | 9(1,9) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.01(0,0.01) | 0(0,0) |
| **4** | 4.017(3.777,4.201) | 10.5(8.25,12) | 1(1,2.5) | 100(3.25,100) | 0.4(0.225,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **5** | 5.3(5.109,5.62) | 9(1.75,10.5) | 2.5(2,3) | 0.1(0.1,77.5) | 0.1(0.1,0.375) | 0.01(0,0.01) | 0(0,0) |
| **6** | 5.743(5.654,5.838) | 10(1,12) | 1.5(1,3.5) | 100(0.1,100) | 0.4(0.1,0.4) | 0.005(0,0.01) | 0(0,0) |
| **7** | 6.179(5.969,6.349) | 4.5(1,11.25) | 1(1,3.5) | 0.1(0.1,100) | 0.1(0.1,0.4) | 0(0,0.01) | 0(0,0) |
| **8** | 7.555(7.325,7.715) | 12(9,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **9** | 8.236(7.706,8.756) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **10** | 8.356(8.035,8.634) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **11** | 8.474(8.241,8.638) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **12** | 9.009(8.102,9.14) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **13** | 8.861(8.574,9.42) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **14** | 8.952(8.858,9.638) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |

Table 63. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

### 3.1.3.8 Figures

The MSPE over Number of HPCA group by Regions: Figure 46

The Correlation over Number of HPCA group by Regions: Figure 47

The Elapsed Time over Number of HPCA group by Regions: Figure 48

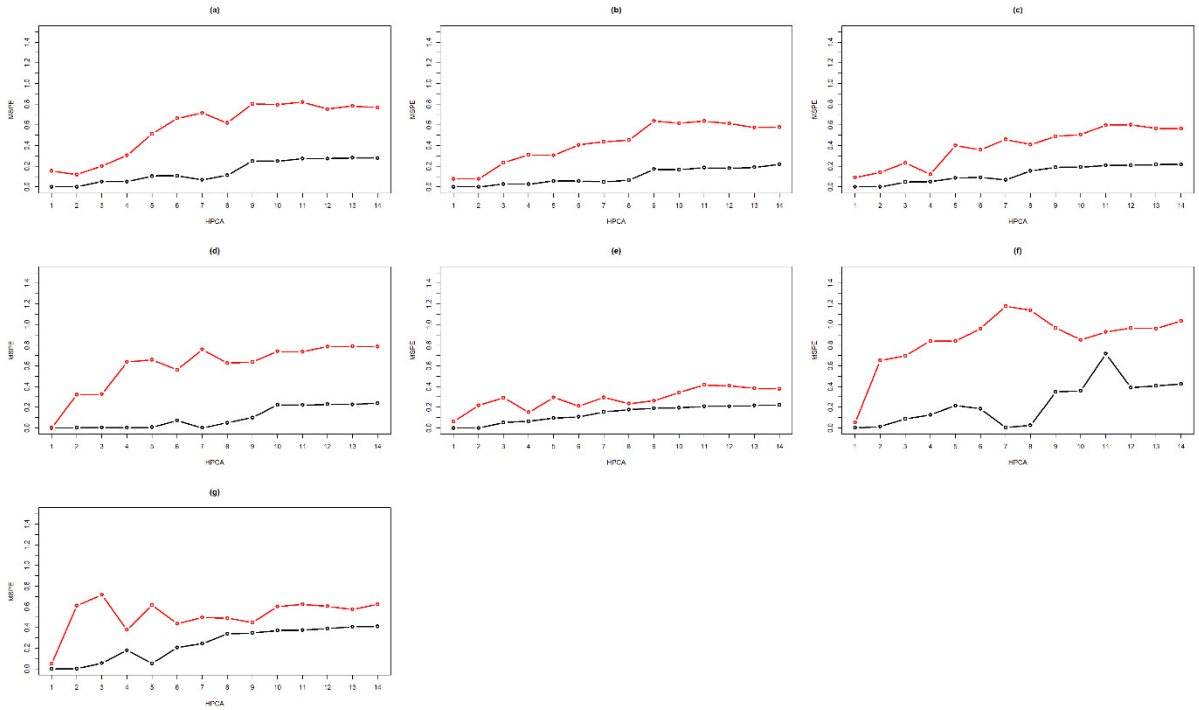



Figure 46. (a-g) Median of mean square prediction error (MSPE) for train (black solid line) and test (red solid line) in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

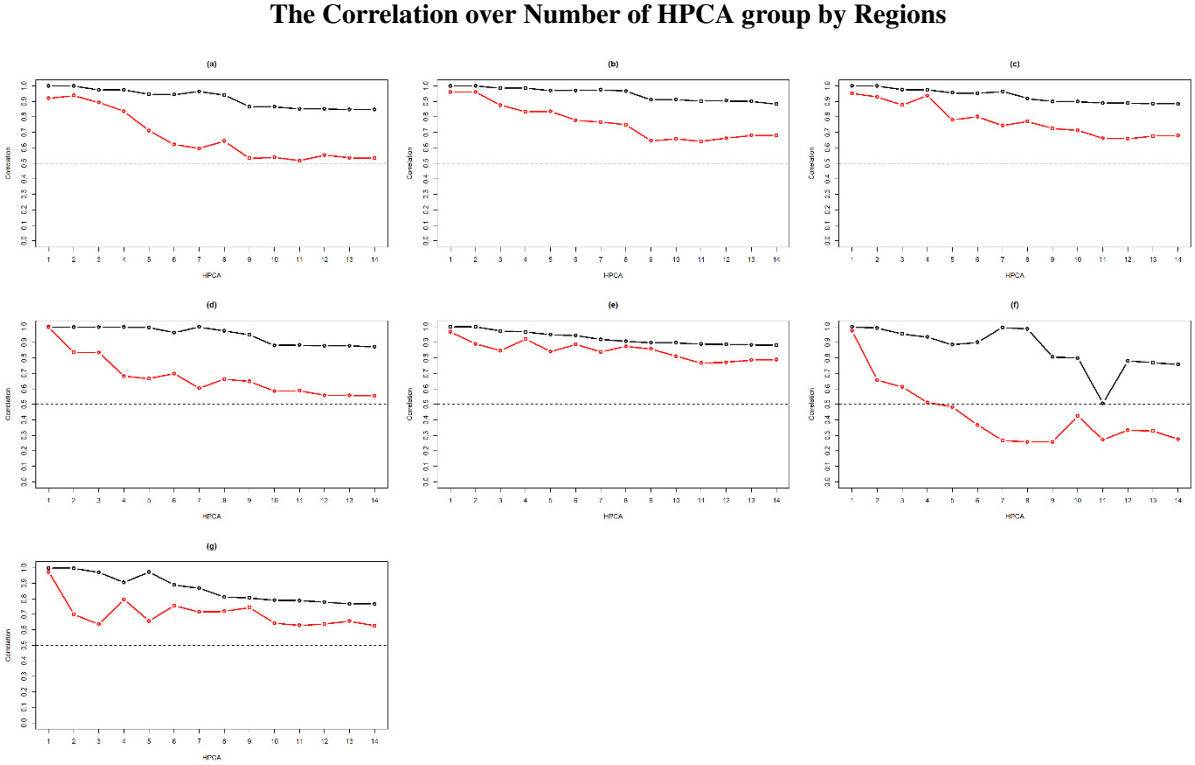



Figure 47. (a-g) Median of correlation for train (black solid line) and test (red solid line) in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

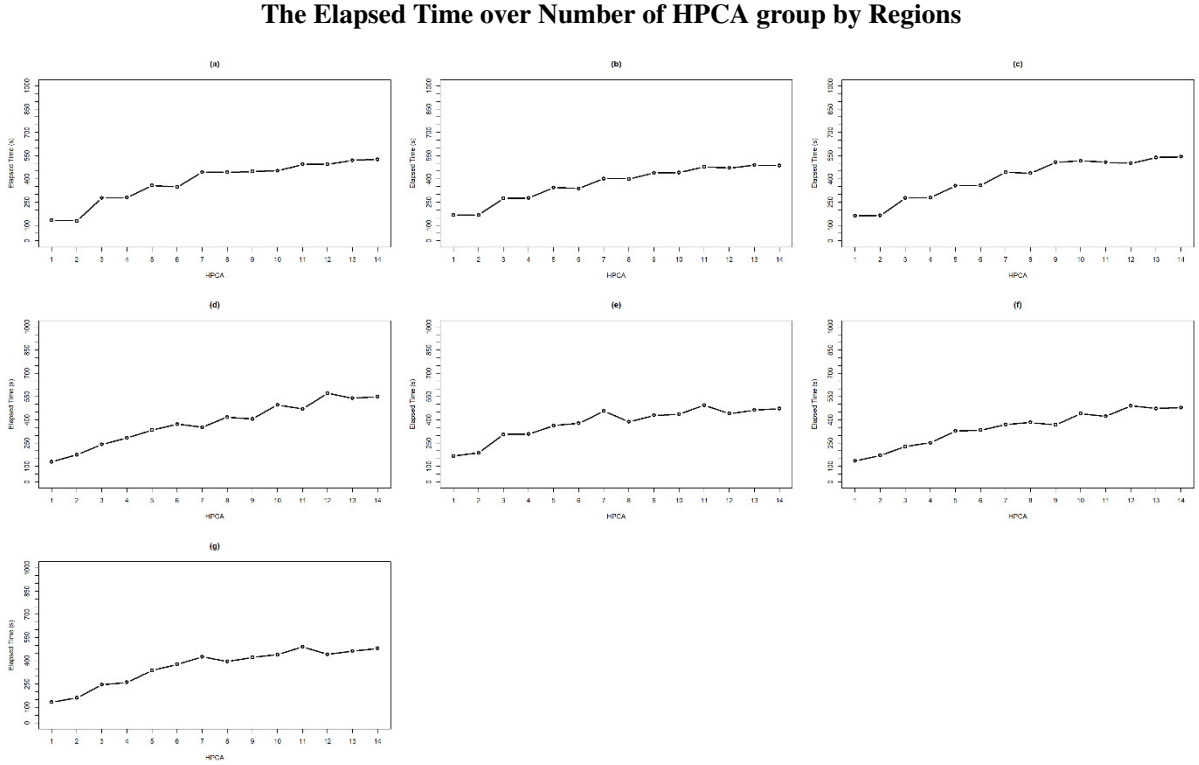



Figure 48. (a-g) Median of elapsed time in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

*3.1.4. Conclusion .*
According to the Figure 46, the MSPE increased by adding HPCA from 1 to KLM in all regions. It also indicates that the difference between training and testing exists. The Figure 47 shows the correlation. The highest correlation is in the first HPCA in all regions fro both training and testing datasets. The elapsed time is also increasing by adding HPCA.(Figure 48)
We conclude that the first HPCA has the best performance based on the MSPE, correlation and elapsed times in all region of the brain.

### *3.2. Target Stimuli*

*3.2.1. The HPCA Decomposition*

#### 3.2.1.1 The Functional dimension

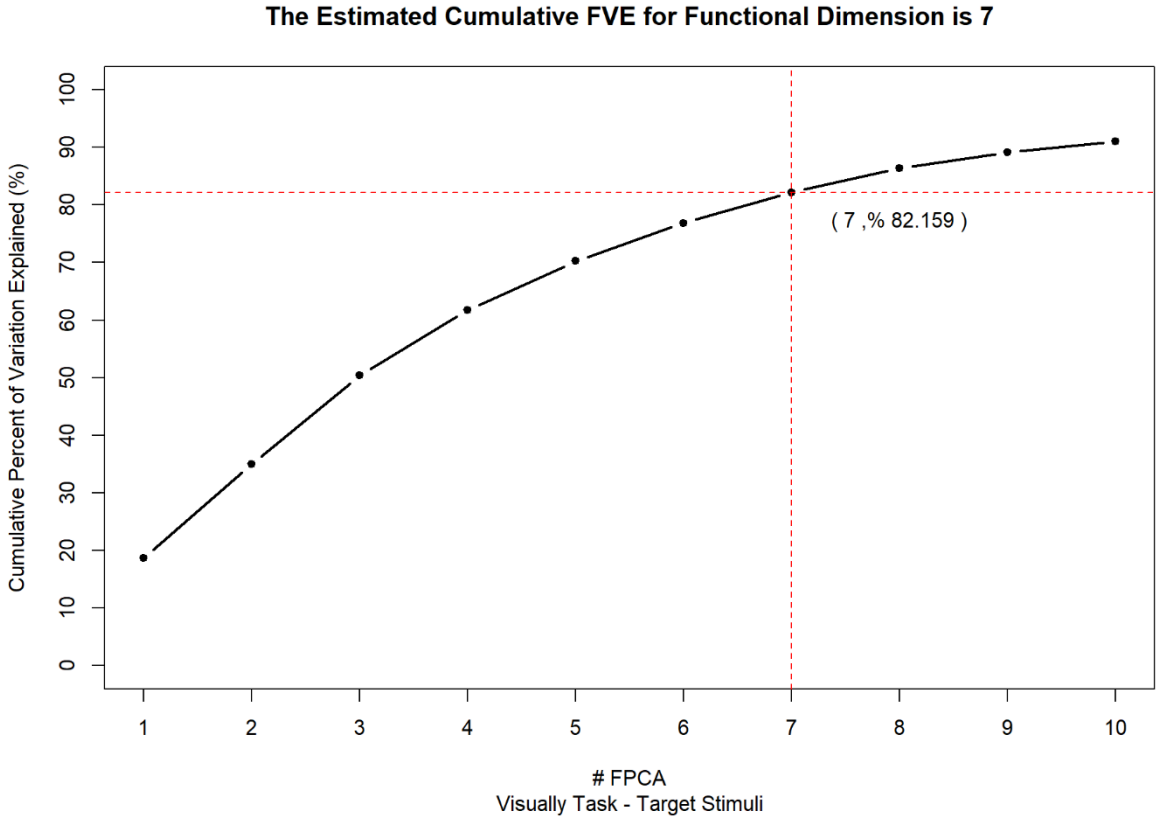



Figure 49. The estimated cumulative fraction of variations (FVE) for functional dimension.

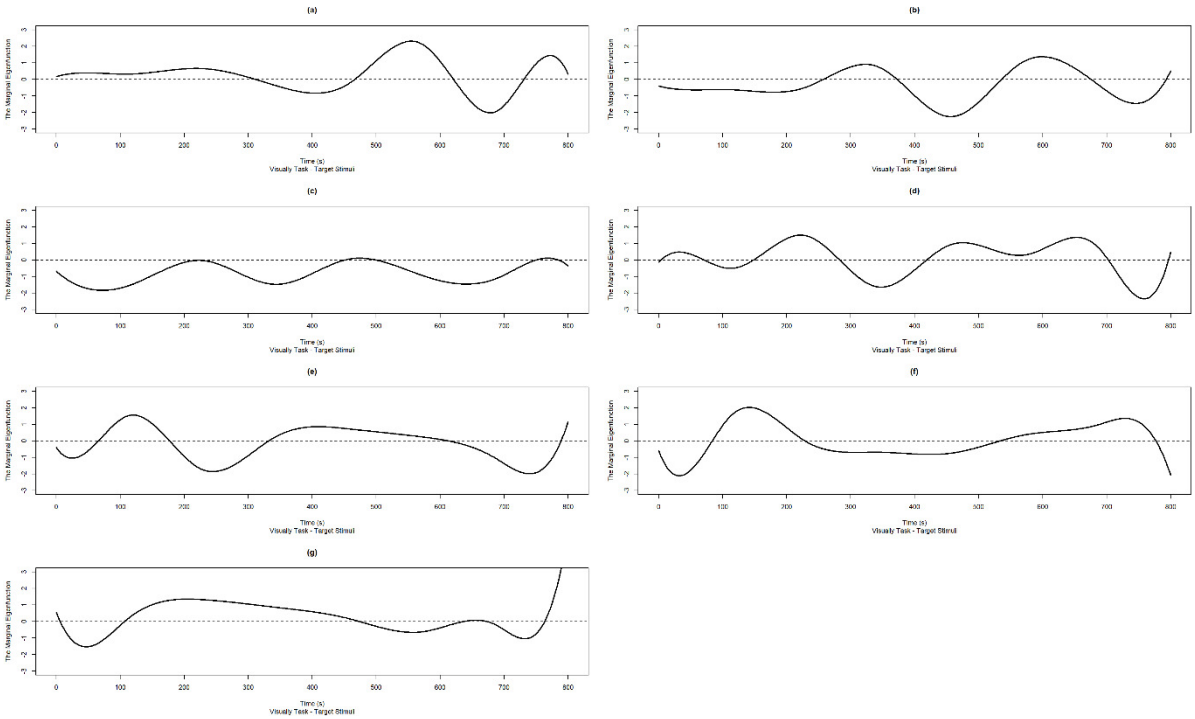



Figure 50. (a, g) Estimated first to seven leading functional marginal eigenfunctions.

According to the Figure 49, the first seven marginal functional principal component analysis (FPCA) capture at least 85% of variation in this dimension. The Figure 50 plots estimated first to seven leading functional marginal eigenfunctions on the x-axis (time).

#### 3.2.1.2 The Longitudinal dimension

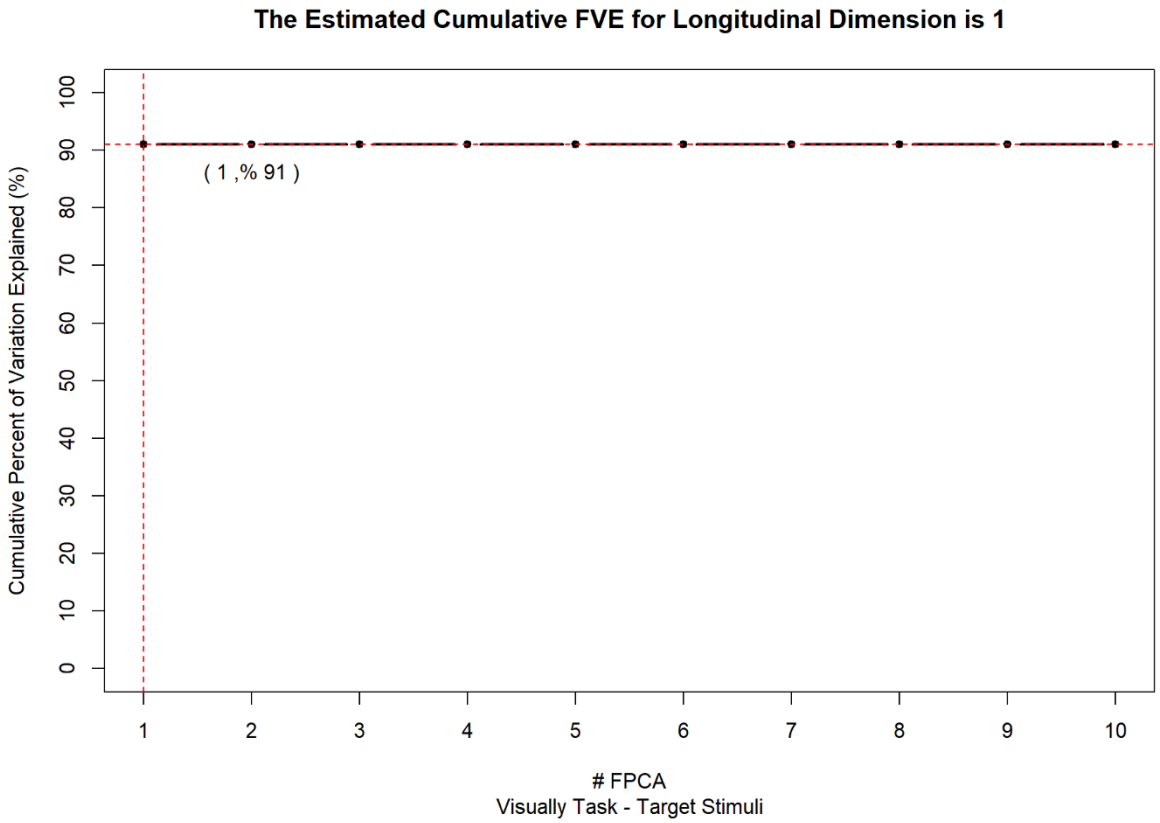



Figure 51. The estimated cumulative fraction of variations (FVE) for longitudinal dimension.

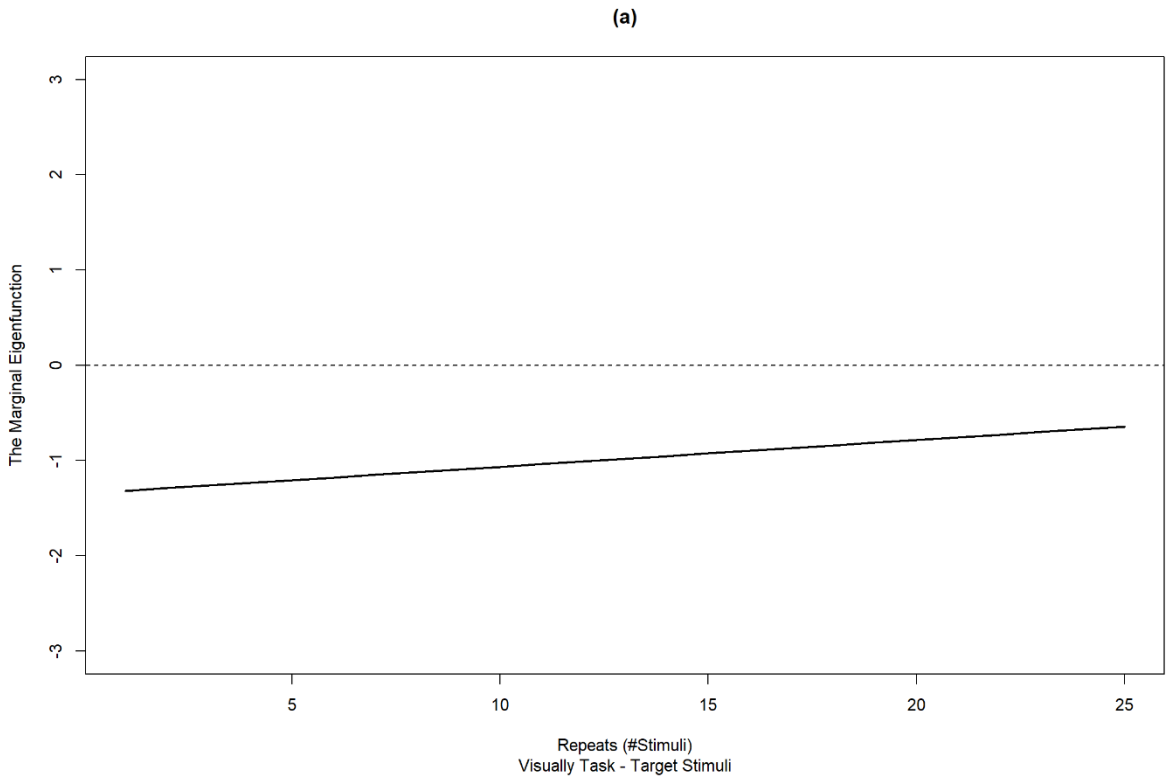



Figure 52. Estimated first leading longitudinal marginal eigenfunctions.

According to the Figure 51, the first marginal functional principal component analysis (FPCA) capture at least 90% of variation in this dimension. The Figure 52 plots estimated first leading longitudinal marginal eigenfunctions on the receptions.

#### 3.2.1.3 The Regional dimension

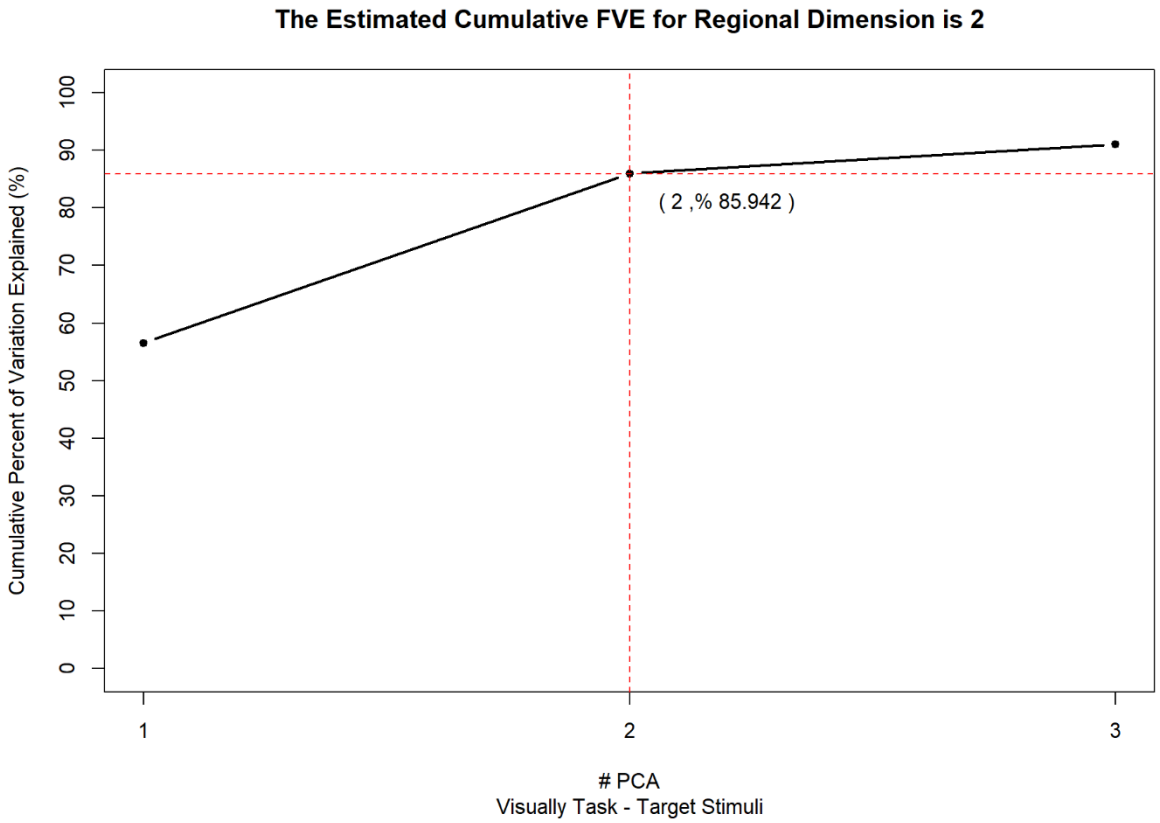



Figure 53. The estimated cumulative fraction of variations (FVE) for regional dimension.

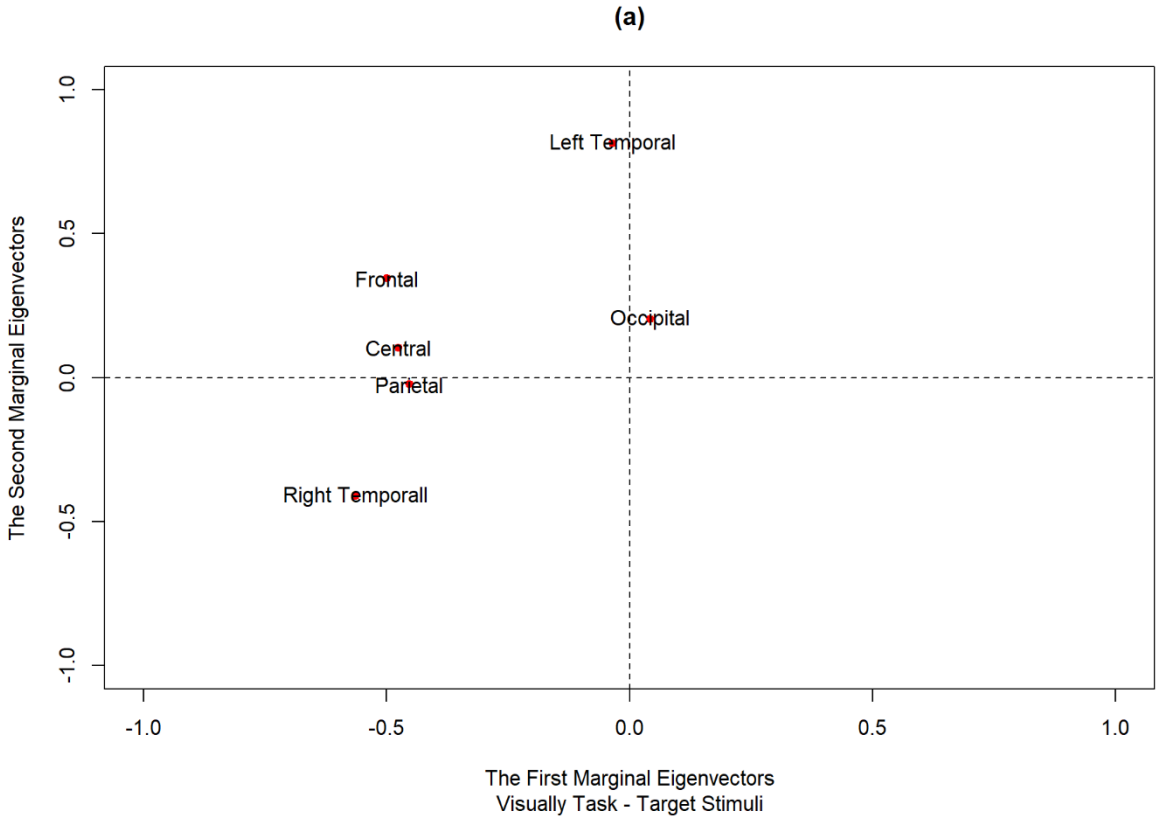



Figure 54. Estimated first and second leading regional marginal eigenvectors.

According to the Figure 53, the first and second marginal principal component analysis (PCA) capture at least nearly 85% of variation in this dimension. The Figure 54 plots estimated first and second leading regional marginal eigenvectors.

*3.2.2. The Reconstructed of the Response .*
The fof regression were conducted group by the number of HPCA and the regions. In the following part, we show the reconstructed ERPs for each subject (in gray) based on the number of HPCA. In this trial, we have 14 HPCA. We also show the point-wise mean and mean ± standard deviation. ( Whole Brain: Figure 55, Frontal region (1): Figure 56, Central Region (2): Figure 57, Occipital Region (3): Figure 58, Parietal Region (4): Figure 59, Left Temporal (5): Figure 60, Right Temporal (6): Figure 61 ).

#### 3.2.2.1 Whole Brain

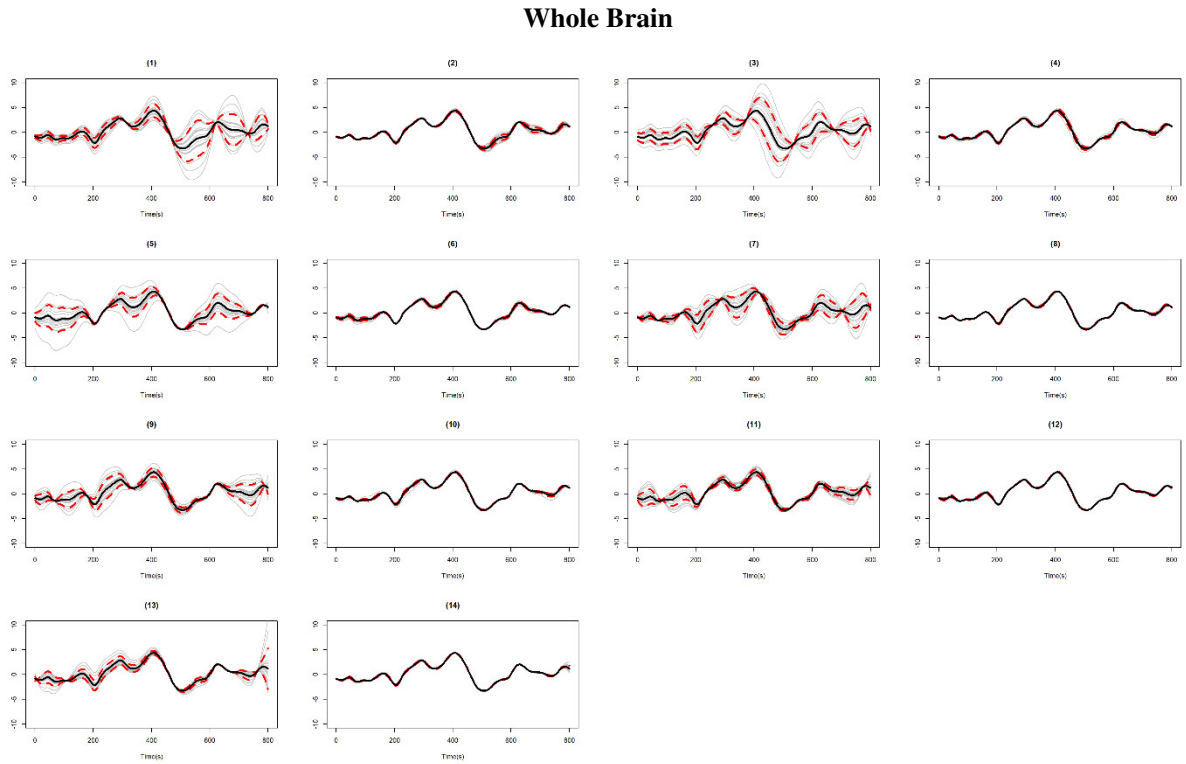



Figure 55. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for whole Brain.

#### 3.2.2.2 Frontal Region (1)

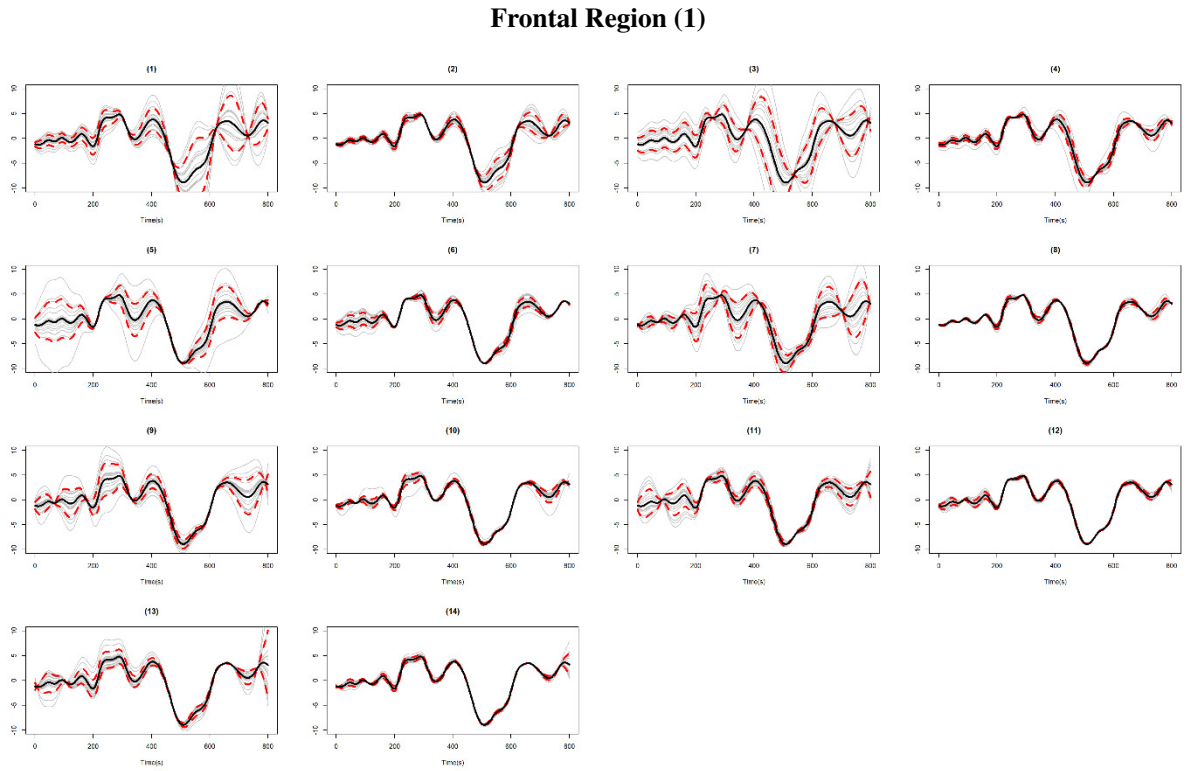



Figure 56. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for frontal region of the Brain.

### 3.2.2.3 Central Region (2)

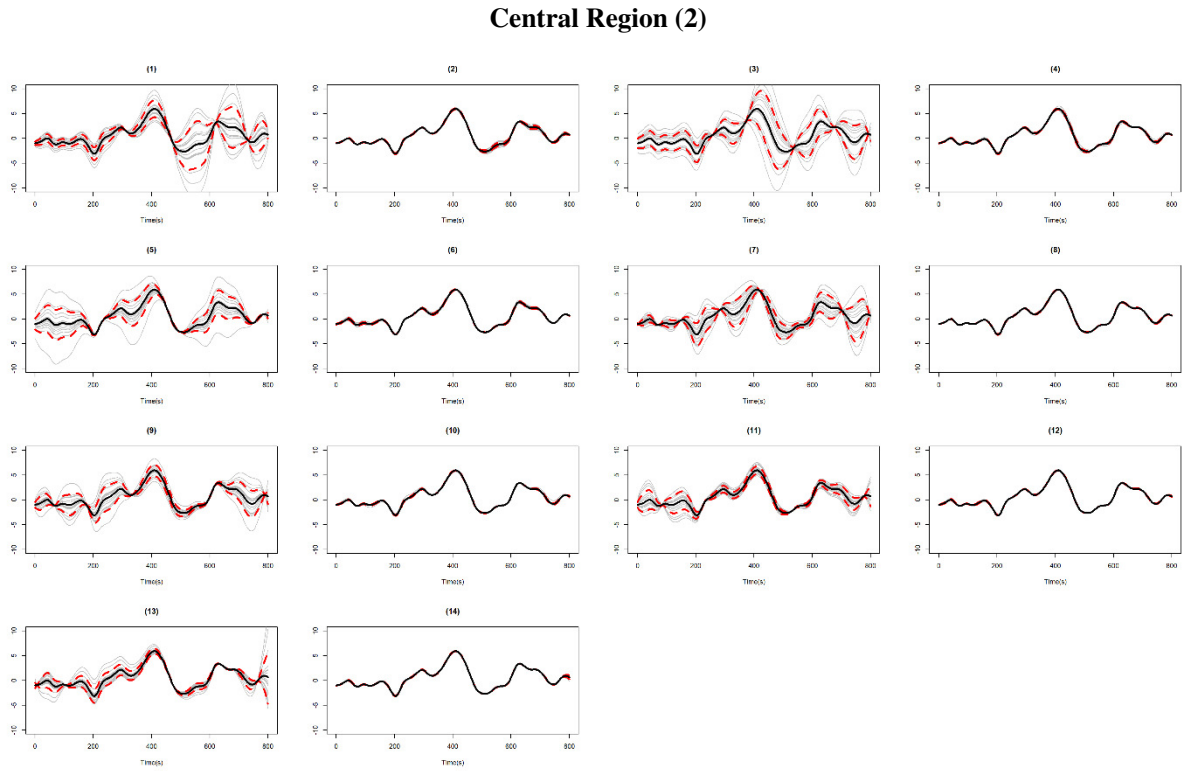



Figure 57. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for central region of the Brain.

#### 3.2.2.4 Occipital Region (3)

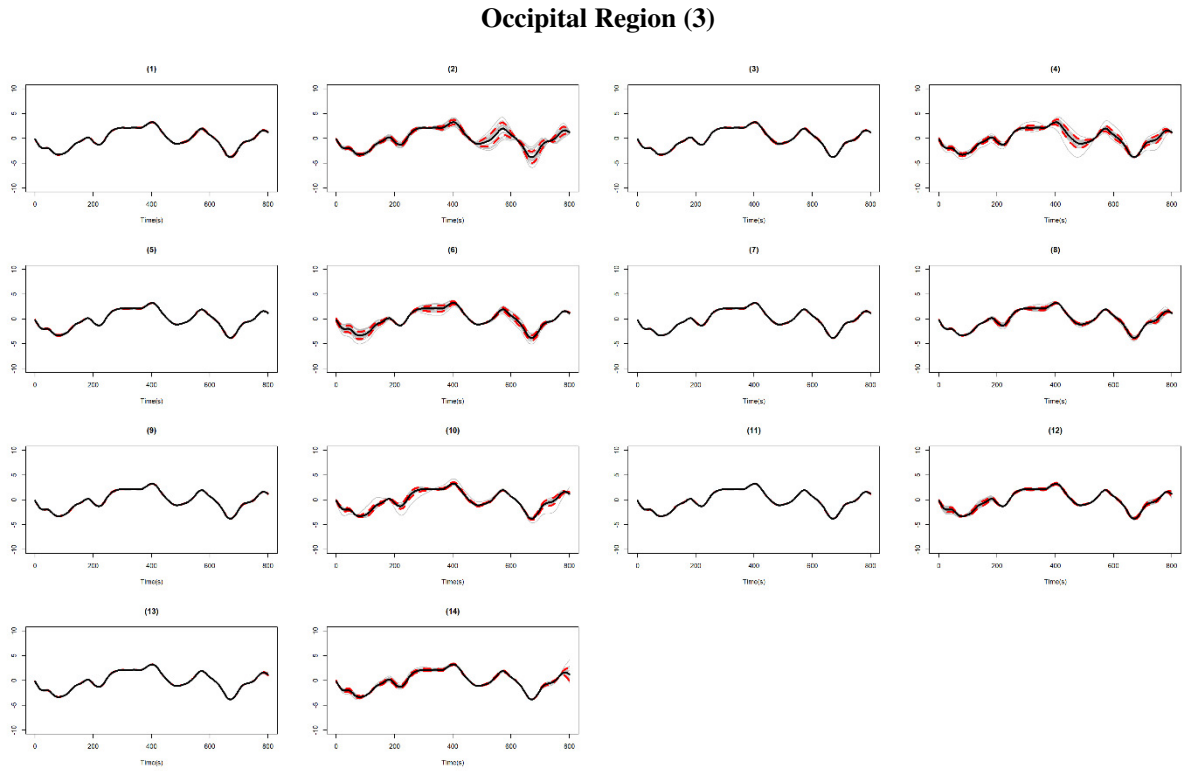



Figure 58. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for occipital region of the Brain.

### 3.2.2.5 Parietal Region (4)

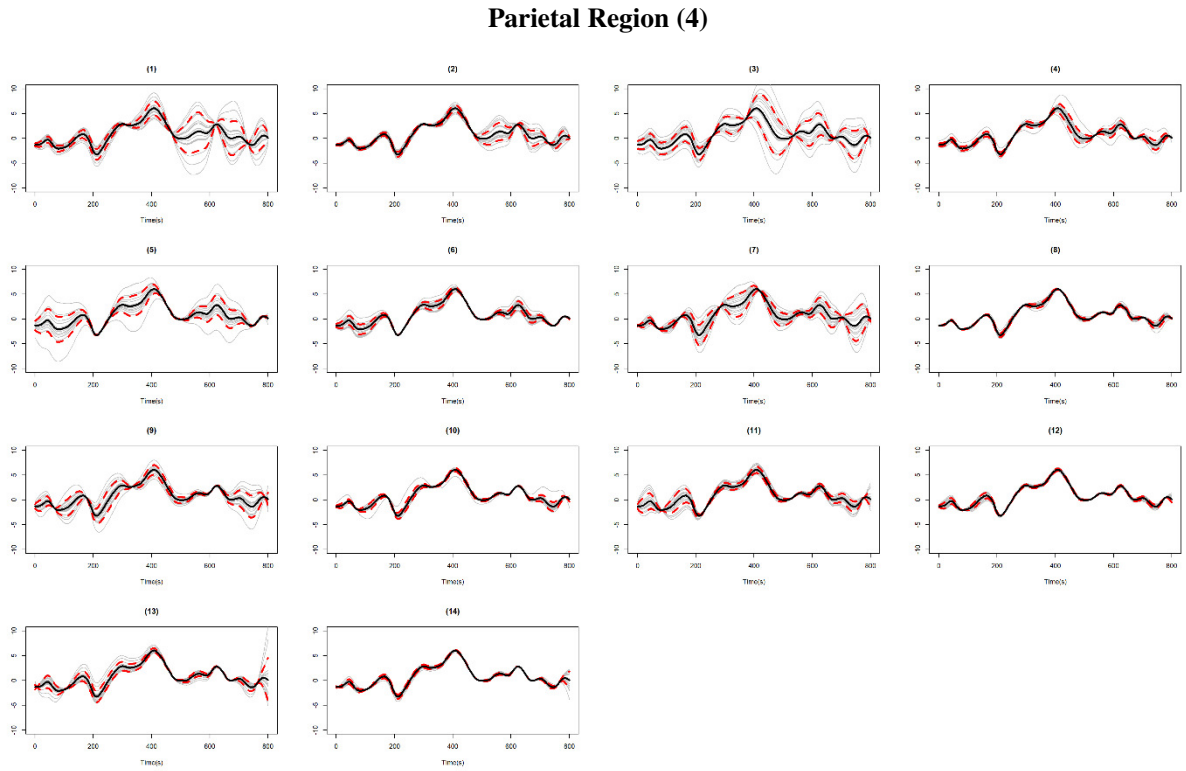



Figure 59. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for parietal region of the Brain.

#### 3.2.2.6 Left Temporal (5)

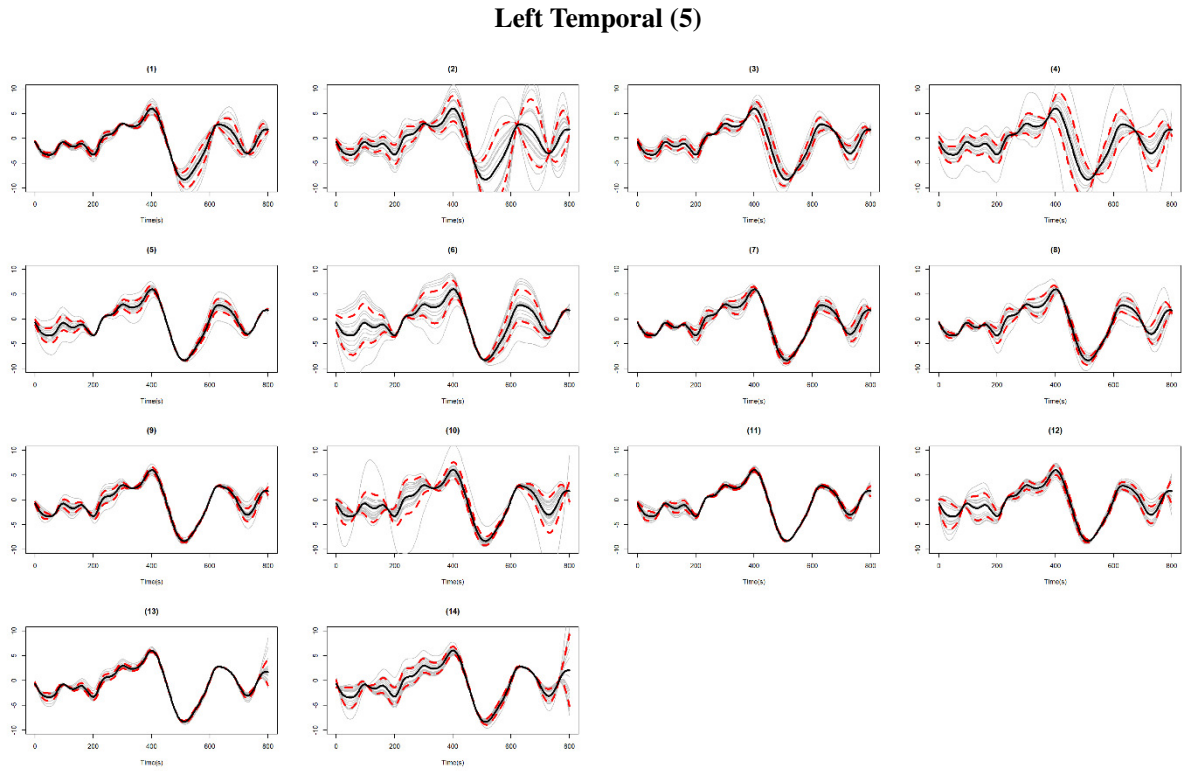



Figure 60. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for left temporal region of the Brain.

### 3.2.2.7 Right Temporal (6)

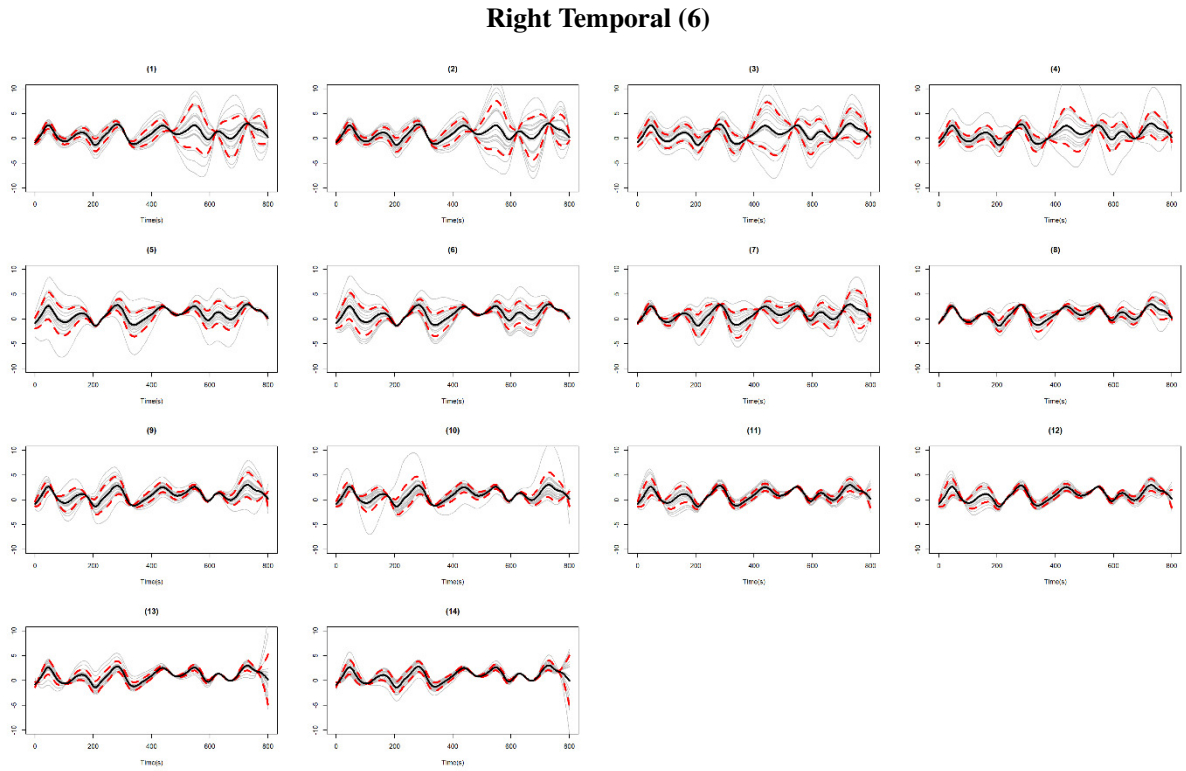



Figure 61. (1-14) Reconstructed ERPs for each subject (Gray line), point-wise mean (solid black line), and mean ± standard deviation (dotted red line) for right temporal region of the Brain.

*3.2.3. The function-on-function result* .
The fof regression result group by the region of the brain and the number of hybrid principal component analysis (HPCA) were reported.

#### 3.2.3.1 Whole Brain

The MSPE and Correlation group by number of HPCA, Train and Test (Table 64)

The User, System and Elapsed Time group by number of HPCA (Table 65): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 66): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.444(0.258,0.497) | 0.545(0.438,0.599) | 0.773(0.731,0.869) | 0.692(0.645,0.755) |
| **2** | 0.316(0.192,0.437) | 0.588(0.543,0.64) | 0.84(0.778,0.899) | 0.66(0.612,0.703) |
| **3** | 0.331(0.32,0.332) | 0.505(0.505,0.508) | 0.817(0.817,0.824) | 0.71(0.709,0.71) |
| **4** | 0.328(0.324,0.328) | 0.487(0.487,0.525) | 0.819(0.819,0.822) | 0.722(0.697,0.722) |
| **5** | 0.341(0.341,0.341) | 0.559(0.559,0.559) | 0.811(0.811,0.811) | 0.679(0.679,0.679) |
| **6** | 0.338(0.338,0.338) | 0.599(0.599,0.6) | 0.813(0.813,0.813) | 0.655(0.655,0.655) |
| **7** | 0.482(0.472,0.482) | 0.637(0.637,0.637) | 0.719(0.719,0.726) | 0.612(0.612,0.612) |
| **8** | 0.634(0.487,0.653) | 0.689(0.655,0.737) | 0.633(0.614,0.717) | 0.572(0.519,0.594) |
| **9** | 0.633(0.556,0.666) | 0.694(0.615,0.71) | 0.63(0.598,0.671) | 0.56(0.546,0.623) |
| **10** | 0.631(0.557,0.666) | 0.707(0.612,0.708) | 0.63(0.597,0.671) | 0.547(0.544,0.624) |
| **11** | 0.47(0.47,0.613) | 0.683(0.678,0.741) | 0.728(0.636,0.728) | 0.576(0.51,0.584) |
| **12** | 0.599(0.468,0.683) | 0.71(0.687,0.759) | 0.642(0.576,0.729) | 0.546(0.491,0.578) |
| **13** | 0.636(0.582,0.7) | 0.855(0.798,0.893) | 0.621(0.56,0.65) | 0.392(0.355,0.48) |
| **14** | 0.633(0.604,0.691) | 0.854(0.777,0.896) | 0.623(0.568,0.642) | 0.393(0.353,0.471) |

Table 64. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 168.715(161.143,176.38) | 0.16(0.088,0.23) | 169.94(161.608,178.215) |
| **2** | 166.94(154.008,183.305) | 0.135(0.09,0.158) | 168.51(154.563,184.663) |
| **3** | 327.46(323.39,330.028) | 0.175(0.16,0.33) | 328.37(324.238,333.67) |
| **4** | 318.93(315.188,320.623) | 0.165(0.15,0.225) | 320.045(316.515,321.395) |
| **5** | 356.46(350.34,360.425) | 0.19(0.163,0.238) | 357.45(351.248,361.522) |
| **6** | 354.865(349.84,357.45) | 0.19(0.137,0.2) | 355.7(350.555,358.248) |
| **7** | 438.385(431.875,448.308) | 0.23(0.215,0.28) | 439.745(433.153,449.355) |
| **8** | 449.37(444.8,451.5) | 0.21(0.175,0.243) | 450.26(445.908,452.617) |
| **9** | 466.72(460.81,470.72) | 0.215(0.173,0.245) | 467.845(461.83,471.713) |
| **10** | 464.585(459.84,471.187) | 0.22(0.167,0.23) | 465.46(460.665,472.24) |
| **11** | 510.275(506.03,520.41) | 0.235(0.192,0.285) | 511.365(506.805,521.725) |
| **12** | 500.905(499.87,519.165) | 0.225(0.175,0.257) | 501.735(500.65,520.31) |
| **13** | 564.01(561.85,567.015) | 0.24(0.193,0.302) | 564.64(562.49,567.8) |
| **14** | 570.475(560.6,575.29) | 0.23(0.2,0.3) | 571.065(561.118,576.287) |

Table 65. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 10.039(9.127,10.515) | 12(9.75,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.003,0.01) |
| **2** | 9.766(9.35,10.066) | 12(5,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0.005(0,0.01) |
| **3** | 7.869(7.433,9.153) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **4** | 8.452(7.974,8.956) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **5** | 8.428(8.07,9.118) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **6** | 8.746(8.18,9.326) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **7** | 11.103(10.188,11.416) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **8** | 12.229(12.058,12.913) | 12(12,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0,0.01) |
| **9** | 12.245(11.899,12.781) | 12(12,12) | 1.5(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.003,0.01) |
| **10** | 12.743(11.594,12.998) | 12(12,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.003,0.01) |
| **11** | 12.236(11.833,12.85) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0.008) |
| **12** | 12.824(12.698,12.923) | 12(12,12) | 2(1.25,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.005(0,0.01) |
| **13** | 12.887(12.341,13.112) | 8(8,12) | 1.5(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0(0,0.01) | 0.01(0.003,0.01) |
| **14** | 12.94(12.677,13.172) | 12(6.75,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0.01(0.01,0.01) |

Table 66. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

#### 3.2.3.2 Frontal Region (1)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 67)

The User, System and Elapsed Time group by number of HPCA (Table 68): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

The Model fitting parameters group by number of HPCA (Table 69): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.175(0.166,0.175) | 0.329(0.326,0.329) | 0.909(0.909,0.913) | 0.819(0.819,0.823) |
| **2** | 0.152(0.055,0.152) | 0.522(0.514,0.522) | 0.921(0.921,0.972) | 0.719(0.719,0.719) |
| **3** | 0.287(0.287,0.287) | 0.506(0.506,0.517) | 0.844(0.844,0.844) | 0.715(0.706,0.715) |
| **4** | 0.282(0.278,0.282) | 0.474(0.474,0.479) | 0.847(0.847,0.849) | 0.736(0.733,0.736) |
| **5** | 0.294(0.288,0.294) | 0.575(0.575,0.599) | 0.84(0.84,0.843) | 0.677(0.639,0.677) |
| **6** | 0.292(0.255,0.292) | 0.647(0.542,0.662) | 0.841(0.841,0.863) | 0.625(0.625,0.69) |
| **7** | 0.428(0.424,0.537) | 0.676(0.675,0.712) | 0.756(0.692,0.759) | 0.587(0.536,0.594) |
| **8** | 0.434(0.427,0.569) | 0.691(0.689,0.727) | 0.752(0.675,0.756) | 0.575(0.522,0.583) |
| **9** | 0.427(0.427,0.486) | 0.66(0.66,0.689) | 0.757(0.717,0.757) | 0.598(0.574,0.598) |
| **10** | 0.564(0.421,0.564) | 0.73(0.675,0.734) | 0.677(0.677,0.761) | 0.519(0.515,0.594) |
| **11** | 0.425(0.425,0.519) | 0.71(0.71,0.723) | 0.758(0.703,0.758) | 0.567(0.535,0.567) |
| **12** | 0.422(0.422,0.422) | 0.725(0.725,0.725) | 0.76(0.76,0.76) | 0.558(0.558,0.558) |
| **13** | 0.565(0.565,0.565) | 0.876(0.876,0.876) | 0.673(0.673,0.673) | 0.394(0.394,0.394) |
| **14** | 0.556(0.458,0.562) | 0.821(0.793,0.873) | 0.679(0.675,0.736) | 0.461(0.398,0.493) |

Table 67. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for frontal region brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 218.345(213.175,221.848) | 0.105(0.082,0.135) | 218.645(213.56,222.15) |
| **2** | 205.185(203.98,206.122) | 0.105(0.053,0.135) | 205.46(204.257,206.502) |
| **3** | 316.81(312.365,321.803) | 0.095(0.08,0.145) | 317.185(312.778,322.167) |
| **4** | 301.97(298.912,305.875) | 0.145(0.1,0.198) | 302.425(299.19,306.237) |
| **5** | 351.81(351.195,353.833) | 0.125(0.08,0.165) | 352.3(351.478,354.388) |
| **6** | 358.74(357.285,365.42) | 0.145(0.13,0.168) | 359.3(357.662,365.765) |
| **7** | 434.1(431.98,439.97) | 0.175(0.16,0.235) | 434.775(432.523,440.43) |
| **8** | 433.56(432.743,446.1) | 0.26(0.213,0.32) | 434.57(433.793,447.135) |
| **9** | 499.855(496.142,504.325) | 0.275(0.227,0.3) | 500.8(497.74,505.27) |
| **10** | 504.96(497.02,513.663) | 0.255(0.22,0.278) | 506.335(498.852,514.852) |
| **11** | 505.04(501.072,517.07) | 0.23(0.19,0.27) | 505.835(502.165,518.5) |
| **12** | 497.58(488.878,509.483) | 0.23(0.205,0.337) | 498.485(489.512,511.962) |
| **13** | 526.46(521.37,533.782) | 0.22(0.175,0.245) | 527.06(522.022,534.465) |
| **14** | 533.31(520.935,534.908) | 0.175(0.147,0.225) | 534.245(521.575,537.73) |

Table 68. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 7.418(7.079,7.597) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **2** | 5.707(5.21,6.397) | 12(6,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **3** | 7.916(7.208,8.489) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **4** | 6.844(6.491,7.541) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **5** | 7.273(6.85,7.583) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **6** | 7.796(7.039,8.073) | 12(12,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **7** | 10.169(9.678,10.927) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0.008) |
| **8** | 11.137(10.292,11.783) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0.01) |
| **9** | 10.957(10.578,11.486) | 12(12,12) | 2(1.25,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **10** | 10.943(10.672,11.133) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0,0.01) |
| **11** | 11.248(10.841,11.516) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0.008) |
| **12** | 10.984(10.415,11.417) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **13** | 11.151(10.975,11.545) | 12(12,12) | 2(2,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.01,0.01) |
| **14** | 11.194(10.958,11.755) | 12(9,12) | 2(1.25,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0.01(0,0.01) |

Table 69. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for frontal region of brain.

#### 3.2.3.3 Central Region (2)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 70)

The User, System and Elapsed Time group by number of HPCA (Table 71): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 72): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.473(0.28,0.533) | 0.638(0.445,0.648) | 0.762(0.712,0.857) | 0.617(0.612,0.757) |
| **2** | 0.533(0.284,0.533) | 0.618(0.468,0.618) | 0.714(0.714,0.855) | 0.649(0.649,0.74) |
| **3** | 0.348(0.337,0.355) | 0.478(0.47,0.488) | 0.807(0.803,0.814) | 0.725(0.719,0.73) |
| **4** | 0.343(0.31,0.349) | 0.503(0.496,0.683) | 0.81(0.807,0.831) | 0.709(0.586,0.714) |
| **5** | 0.367(0.325,0.367) | 0.551(0.551,0.568) | 0.795(0.795,0.821) | 0.679(0.676,0.69) |
| **6** | 0.369(0.369,0.547) | 0.538(0.535,0.603) | 0.794(0.709,0.794) | 0.688(0.662,0.689) |
| **7** | 0.692(0.532,0.692) | 0.716(0.578,0.716) | 0.586(0.586,0.684) | 0.553(0.553,0.65) |
| **8** | 0.692(0.565,0.882) | 0.711(0.593,0.843) | 0.586(0.329,0.664) | 0.559(0.466,0.641) |
| **9** | 0.653(0.595,0.705) | 0.65(0.547,0.662) | 0.62(0.568,0.643) | 0.617(0.61,0.678) |
| **10** | 0.705(0.664,0.705) | 0.664(0.655,0.664) | 0.568(0.568,0.61) | 0.607(0.607,0.613) |
| **11** | 0.87(0.656,0.924) | 0.884(0.731,0.892) | 0.387(0.283,0.611) | 0.379(0.344,0.525) |
| **12** | 0.657(0.585,0.725) | 0.7(0.553,0.727) | 0.61(0.542,0.644) | 0.563(0.53,0.668) |
| **13** | 0.911(0.739,0.931) | 0.901(0.734,0.907) | 0.31(0.27,0.53) | 0.337(0.315,0.527) |
| **14** | 0.734(0.662,0.869) | 0.808(0.735,0.909) | 0.534(0.394,0.605) | 0.437(0.311,0.525) |

Table 70. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for central region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 220.365(214.725,221.885) | 0.17(0.133,0.212) | 220.91(215.255,222.393) |
| **2** | 223.38(219.653,228.685) | 0.085(0.065,0.15) | 224.445(219.945,229.237) |
| **3** | 322.7(321.922,325.2) | 0.15(0.133,0.215) | 323.45(322.463,325.658) |
| **4** | 323.415(319.345,325.37) | 0.14(0.122,0.177) | 323.725(319.862,325.617) |
| **5** | 361.27(360.655,366.165) | 0.14(0.085,0.2) | 361.715(361.277,366.628) |
| **6** | 365.8(361.9,368.033) | 0.17(0.118,0.19) | 366.255(362.355,368.48) |
| **7** | 445.965(442.86,449.15) | 0.16(0.145,0.17) | 446.255(443.355,449.63) |
| **8** | 456.06(453.188,462.875) | 0.19(0.175,0.243) | 456.56(453.692,463.493) |
| **9** | 517.325(508.728,525.685) | 0.2(0.19,0.215) | 517.85(509.223,526.208) |
| **10** | 469.56(460.123,478.21) | 0.165(0.145,0.177) | 470.15(460.795,478.643) |
| **11** | 505.39(502.915,512.243) | 0.165(0.143,0.198) | 505.89(503.663,512.798) |
| **12** | 503.285(498.54,506.713) | 0.19(0.155,0.208) | 503.935(499.068,507.493) |
| **13** | 561.45(551.643,567.152) | 0.24(0.163,0.348) | 562.48(552.598,567.783) |
| **14** | 560.96(553.13,566.22) | 0.21(0.192,0.243) | 561.845(554.095,567.1) |

Table 71. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for central region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 10.771(10.508,11.298) | 12(9,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0.01(0.003,0.01) |
| **2** | 10.748(10.075,11.169) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.003,0.01) |
| **3** | 9.034(8.397,9.873) | 10(5,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0(0,0) |
| **4** | 8.492(8.096,8.919) | 11(8,11) | 1(1,1) | 100(10,100) | 0.4(0.3,0.4) | 0.01(0,0.01) | 0(0,0) |
| **5** | 9.688(8.459,10.539) | 11.5(5.75,12) | 1(1,1) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **6** | 9.985(9.031,10.811) | 12(12,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0.01) |
| **7** | 12.777(12.536,12.974) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0,0.01) |
| **8** | 12.495(12.035,13.358) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.003,0.753) |
| **9** | 12.647(12.069,13.058) | 12(12,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.003,0.01) |
| **10** | 13.201(12.706,13.449) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.01,0.01) |
| **11** | 13.462(13.145,13.498) | 10(5,12) | 2(1.25,2) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 1(0.01,1) |
| **12** | 12.826(12.29,13.071) | 12(9,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0.01(0,0.01) |
| **13** | 13.438(13.352,13.53) | 11.5(8,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 1(0.01,1) |
| **14** | 13.382(13.177,13.479) | 10(5,12) | 2(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0.01(0.01,1) |

Table 72. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for central region of the brain.

#### 3.2.3.4 Occipital Region (3)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 73)

The User, System and Elapsed Time group by number of HPCA (Table 74): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 75): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.001(0,0.001) | 0.002(0.001,0.002) | 1(1,1) | 0.999(0.999,0.999) |
| **2** | 0.002(0.002,0.002) | 0.18(0.18,0.18) | 0.999(0.999,0.999) | 0.908(0.908,0.908) |
| **3** | 0.003(0.003,0.024) | 0.182(0.182,0.208) | 0.998(0.988,0.998) | 0.907(0.895,0.907) |
| **4** | 0.053(0.053,0.053) | 0.194(0.194,0.194) | 0.973(0.973,0.973) | 0.9(0.9,0.9) |
| **5** | 0.053(0.053,0.053) | 0.19(0.19,0.19) | 0.973(0.973,0.973) | 0.902(0.902,0.902) |
| **6** | 0.066(0.023,0.066) | 0.172(0.172,0.206) | 0.967(0.967,0.988) | 0.911(0.894,0.911) |
| **7** | 0.066(0.023,0.066) | 0.173(0.173,0.209) | 0.967(0.967,0.988) | 0.911(0.892,0.911) |
| **8** | 0.071(0.071,0.071) | 0.205(0.205,0.205) | 0.964(0.964,0.964) | 0.894(0.894,0.894) |
| **9** | 0.071(0.071,0.071) | 0.205(0.205,0.205) | 0.964(0.964,0.964) | 0.894(0.894,0.894) |
| **10** | 0.095(0.095,0.095) | 0.2(0.2,0.2) | 0.951(0.951,0.951) | 0.896(0.896,0.896) |
| **11** | 0.095(0.095,0.095) | 0.201(0.201,0.201) | 0.951(0.951,0.951) | 0.895(0.895,0.895) |
| **12** | 0.102(0.102,0.102) | 0.219(0.219,0.219) | 0.948(0.948,0.948) | 0.886(0.886,0.886) |
| **13** | 0.102(0.102,0.102) | 0.22(0.22,0.22) | 0.948(0.948,0.948) | 0.885(0.885,0.885) |
| **14** | 0.104(0.104,0.104) | 0.213(0.213,0.213) | 0.946(0.946,0.946) | 0.889(0.889,0.889) |

Table 73. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 143.385(141.523,144.563) | 0.095(0.06,0.138) | 143.685(141.695,144.755) |
| **2** | 186.47(183.667,189.717) | 0.075(0.07,0.112) | 186.875(183.997,190.005) |
| **3** | 219.855(217.753,222.37) | 0.1(0.063,0.108) | 220.125(218.038,222.59) |
| **4** | 323(315.808,325.338) | 0.11(0.102,0.14) | 323.405(316.158,326.018) |
| **5** | 304.89(301.05,307.197) | 0.155(0.132,0.2) | 305.41(301.477,308.17) |
| **6** | 369.33(364.565,374.962) | 0.17(0.115,0.257) | 369.97(365.073,375.595) |
| **7** | 342.45(337.37,350.225) | 0.145(0.09,0.26) | 342.97(338.15,350.755) |
| **8** | 409.84(399.265,411.34) | 0.15(0.117,0.178) | 410.295(399.753,411.9) |
| **9** | 431.045(425.51,435.938) | 0.18(0.12,0.227) | 431.555(426.555,436.908) |
| **10** | 429.645(426.66,440.167) | 0.18(0.162,0.208) | 430.205(427.167,440.88) |
| **11** | 434.305(430.528,437.292) | 0.2(0.135,0.235) | 435.005(431.117,437.805) |
| **12** | 502.24(496.112,527.575) | 0.21(0.175,0.417) | 503.79(496.77,608.355) |
| **13** | 515.18(513.065,520.54) | 0.275(0.218,0.315) | 517.12(514.697,522.903) |
| **14** | 510.005(507.388,524.177) | 0.245(0.205,0.308) | 510.615(508.185,526.305) |

Table 74. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 0.027(0.025,0.028) | 12(12,12) | 1.5(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **2** | 1.917(1.817,2.1) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **3** | 1.983(1.784,2.21) | 1(1,3.25) | 1(1,1) | 0.1(0.1,75.025) | 0.1(0.1,0.325) | 0(0,0) | 0(0,0) |
| **4** | 2.267(2.005,2.435) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **5** | 2.364(2.226,2.428) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **6** | 2.999(2.931,3.086) | 1(1,1) | 1(1,1.75) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **7** | 2.795(2.772,3.035) | 1(1,1) | 1(1,1.75) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **8** | 2.893(2.758,2.984) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **9** | 2.897(2.739,3.035) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **10** | 3.265(3.129,3.34) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **11** | 3.508(3.351,3.553) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **12** | 3.699(3.45,3.825) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **13** | 3.607(3.42,3.647) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **14** | 3.244(3.156,3.437) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |

Table 75. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for occipital region of the brain.

#### 3.2.3.5 Parietal (4)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 76)

The User, System and Elapsed Time group by number of HPCA (Table 77): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 78): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.329(0.174,0.392) | 0.402(0.4,0.472) | 0.831(0.788,0.909) | 0.785(0.729,0.791) |
| **2** | 0.402(0.361,0.41) | 0.362(0.345,0.378) | 0.783(0.777,0.811) | 0.817(0.802,0.832) |
| **3** | 0.309(0.28,0.311) | 0.292(0.292,0.298) | 0.831(0.83,0.848) | 0.842(0.838,0.842) |
| **4** | 0.447(0.349,0.448) | 0.512(0.394,0.563) | 0.758(0.758,0.81) | 0.709(0.668,0.782) |
| **5** | 0.328(0.316,0.34) | 0.399(0.395,0.402) | 0.819(0.812,0.827) | 0.776(0.775,0.778) |
| **6** | 0.392(0.353,0.475) | 0.398(0.378,0.457) | 0.787(0.736,0.804) | 0.787(0.758,0.788) |
| **7** | 0.597(0.57,0.616) | 0.541(0.5,0.566) | 0.645(0.629,0.669) | 0.7(0.669,0.742) |
| **8** | 0.612(0.508,0.612) | 0.526(0.414,0.526) | 0.631(0.631,0.702) | 0.711(0.711,0.772) |
| **9** | 0.635(0.616,0.64) | 0.495(0.483,0.498) | 0.611(0.607,0.628) | 0.741(0.74,0.748) |
| **10** | 0.588(0.518,0.636) | 0.475(0.356,0.503) | 0.654(0.611,0.694) | 0.764(0.734,0.807) |
| **11** | 0.663(0.612,0.755) | 0.553(0.537,0.707) | 0.586(0.521,0.632) | 0.691(0.6,0.709) |
| **12** | 0.786(0.786,0.786) | 0.775(0.771,0.775) | 0.499(0.499,0.499) | 0.54(0.539,0.54) |
| **13** | 0.782(0.782,0.782) | 0.796(0.796,0.796) | 0.506(0.506,0.506) | 0.497(0.497,0.497) |
| **14** | 0.786(0.783,0.8) | 0.793(0.789,0.794) | 0.504(0.485,0.507) | 0.498(0.498,0.51) |

Table 76. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 212.225(210.46,213.86) | 0.115(0.065,0.17) | 212.565(210.907,214.235) |
| **2** | 209.245(206.64,209.845) | 0.11(0.102,0.203) | 209.645(207.033,210.28) |
| **3** | 334.46(329.627,335.858) | 0.15(0.118,0.188) | 335.32(330.417,336.377) |
| **4** | 339.975(336.457,344.645) | 0.16(0.133,0.185) | 340.555(336.87,345.205) |
| **5** | 339.14(330.145,344.805) | 0.135(0.13,0.185) | 339.425(330.617,345.6) |
| **6** | 335.505(330.57,338.158) | 0.15(0.132,0.178) | 335.775(330.96,338.677) |
| **7** | 395.98(391.73,401.565) | 0.15(0.143,0.34) | 396.415(392.085,401.935) |
| **8** | 393.225(388.58,398.12) | 0.165(0.132,0.212) | 393.65(388.902,398.615) |
| **9** | 393.86(387.64,401.985) | 0.155(0.125,0.17) | 394.15(387.93,402.495) |
| **10** | 393.455(387.81,399.482) | 0.15(0.14,0.19) | 393.745(388.227,401.177) |
| **11** | 446.54(438.563,449.64) | 0.19(0.145,0.218) | 447.16(439.078,450.178) |
| **12** | 452.215(444.308,455.963) | 0.12(0.112,0.167) | 452.65(444.698,456.382) |
| **13** | 488.355(484.348,492.717) | 0.18(0.17,0.22) | 488.935(484.968,494.722) |
| **14** | 487.125(474.545,491.555) | 0.18(0.153,0.228) | 487.54(474.993,492) |

Table 77. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 8.529(7.209,8.8) | 12(5,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0.01(0,0.01) |
| **2** | 9.035(8.486,9.458) | 12(9.75,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.01,0.01) |
| **3** | 7.538(7.124,8.19) | 12(8.75,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.003,0.01) | 0(0,0) |
| **4** | 9.222(8.665,9.843) | 12(1,12) | 1(1,1) | 100(0.1,100) | 0.4(0.1,0.4) | 0.01(0,0.01) | 0.01(0.003,0.01) |
| **5** | 8.546(8.341,8.881) | 12(4,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0(0,0) |
| **6** | 9.415(8.649,9.722) | 12(12,12) | 1(1,2) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.005(0,0.01) |
| **7** | 11.5(10.916,11.627) | 12(11.25,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.01,0.01) |
| **8** | 10.987(10.728,11.561) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0.003,0.01) |
| **9** | 11.628(11.144,11.726) | 10(8,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.005(0,0.01) | 0.01(0.01,0.01) |
| **10** | 11.507(10.94,12.059) | 12(12,12) | 1(1,1.75) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0.01(0,0.01) |
| **11** | 11.95(11.825,12.124) | 12(8,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0,0.01) | 0.01(0.01,0.753) |
| **12** | 12.109(12.025,12.148) | 1.5(1,6.25) | 7(4.75,7) | 0.55(0.1,77.5) | 0.15(0.1,0.375) | 0(0,0) | 1(1,1) |
| **13** | 12.089(12.068,12.12) | 1(1,3.25) | 8(8,8) | 0.1(0.1,75.025) | 0.1(0.1,0.325) | 0(0,0) | 1(1,1) |
| **14** | 12.194(12.101,12.223) | 4.5(1,11) | 5.5(2.5,7.75) | 50.05(0.1,100) | 0.25(0.1,0.4) | 0(0,0.008) | 1(1,1) |

Table 78. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for parietal region of the brain.

#### 3.2.3.6 Left Temporal (5)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 79)

The User, System and Elapsed Time group by number of HPCA (Table 80): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 81): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.03(0.024,0.03) | 0.071(0.071,0.071) | 0.985(0.985,0.988) | 0.964(0.964,0.964) |
| **2** | 0.057(0.037,0.129) | 0.711(0.698,0.738) | 0.971(0.934,0.981) | 0.595(0.583,0.606) |
| **3** | 0.147(0.106,0.189) | 0.694(0.679,0.749) | 0.924(0.901,0.946) | 0.595(0.548,0.601) |
| **4** | 0.232(0.197,0.267) | 0.775(0.739,0.776) | 0.876(0.856,0.896) | 0.55(0.55,0.563) |
| **5** | 0.216(0.185,0.275) | 0.762(0.751,0.938) | 0.885(0.852,0.903) | 0.546(0.449,0.546) |
| **6** | 0.256(0.256,0.263) | 0.616(0.616,0.756) | 0.862(0.859,0.862) | 0.627(0.536,0.627) |
| **7** | 0.291(0.291,0.291) | 0.597(0.597,0.597) | 0.842(0.842,0.842) | 0.637(0.637,0.637) |
| **8** | 0.316(0.316,0.316) | 0.805(0.805,0.832) | 0.827(0.827,0.827) | 0.482(0.465,0.482) |
| **9** | 0.336(0.336,0.336) | 0.803(0.803,0.825) | 0.815(0.815,0.815) | 0.48(0.467,0.48) |
| **10** | 0.371(0.371,0.376) | 0.723(0.722,0.749) | 0.793(0.79,0.793) | 0.533(0.511,0.536) |
| **11** | 0.383(0.376,0.383) | 0.732(0.73,0.757) | 0.786(0.786,0.789) | 0.524(0.508,0.528) |
| **12** | 0.402(0.399,0.405) | 0.721(0.72,0.722) | 0.773(0.771,0.775) | 0.532(0.53,0.534) |
| **13** | 0.4(0.394,0.4) | 0.767(0.761,0.767) | 0.774(0.774,0.778) | 0.493(0.493,0.503) |
| **14** | 0.424(0.424,0.424) | 0.728(0.728,0.728) | 0.759(0.759,0.759) | 0.525(0.525,0.525) |

Table 79. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 148.545(147.735,148.967) | 0.08(0.065,0.135) | 148.775(147.89,149.105) |
| **2** | 175.77(172.21,178.328) | 0.105(0.085,0.138) | 175.96(172.39,178.51) |
| **3** | 235.465(232.122,239.198) | 0.115(0.077,0.22) | 235.775(232.405,239.46) |
| **4** | 263.25(261.567,266.112) | 0.13(0.088,0.167) | 263.63(261.783,266.348) |
| **5** | 296.825(293.233,300.13) | 0.125(0.102,0.137) | 297.06(293.493,300.55) |
| **6** | 327.705(326.283,333.48) | 0.125(0.102,0.15) | 327.935(326.665,333.915) |
| **7** | 392.24(385.547,395.955) | 0.16(0.12,0.178) | 392.65(385.89,396.38) |
| **8** | 383.52(377.318,386.302) | 0.165(0.118,0.19) | 383.95(377.673,386.742) |
| **9** | 371.84(367.83,373.81) | 0.135(0.095,0.14) | 372.05(368.193,374.555) |
| **10** | 384.705(379.76,388.762) | 0.145(0.115,0.197) | 384.98(380.118,389.575) |
| **11** | 413.915(411.235,417.465) | 0.175(0.13,0.198) | 414.295(411.713,417.77) |
| **12** | 445.94(443.623,450.29) | 0.185(0.135,0.2) | 446.405(443.928,450.69) |
| **13** | 460.235(456.767,462.132) | 0.165(0.142,0.21) | 460.74(457.005,462.51) |
| **14** | 481.795(467.27,496.51) | 0.17(0.14,0.238) | 482.225(467.615,497.065) |

Table 80. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 1.662(1.554,1.801) | 12(12,12) | 1(1,1) | 100(100,100) | 0.4(0.4,0.4) | 0.01(0.01,0.01) | 0(0,0) |
| **2** | 6.441(5.614,6.696) | 2.5(1,4) | 1(1,1) | 50.05(0.1,100) | 0.25(0.1,0.4) | 0(0,0) | 0(0,0) |
| **3** | 7.156(6.884,8.136) | 4(1.5,4) | 1(1,1.75) | 100(2.575,100) | 0.4(0.15,0.4) | 0(0,0) | 0(0,0) |
| **4** | 7.761(7.635,7.919) | 4(1.75,4) | 1(1,1) | 100(25.075,100) | 0.4(0.175,0.4) | 0(0,0) | 0(0,0) |
| **5** | 7.56(7.243,8.29) | 4(3.25,4) | 1(1,2.5) | 100(32.5,100) | 0.4(0.325,0.4) | 0(0,0) | 0(0,0) |
| **6** | 9.175(8.545,9.325) | 1(1,3.25) | 1(1,1) | 0.1(0.1,75.025) | 0.1(0.1,0.325) | 0(0,0) | 0(0,0) |
| **7** | 9.65(9.459,10.059) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **8** | 9.94(9.634,10.193) | 1(1,1.75) | 1(1,1) | 0.1(0.1,0.775) | 0.1(0.1,0.175) | 0(0,0) | 0(0,0) |
| **9** | 10.092(9.759,10.39) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **10** | 10.867(10.67,10.957) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **11** | 11.145(10.444,11.266) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **12** | 10.81(10.421,11.711) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **13** | 11.053(10.597,11.403) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |
| **14** | 11.896(11.599,12.262) | 1(1,1) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0(0,0) | 0(0,0) |

Table 81. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for left temporal region of the brain.

#### 3.2.3.7 Right Temporal (6)

The MSPE and Correlation group by number of HPCA, Train and Test (Table 82)

The User, System and Elapsed Time group by number of HPCA (Table 83): The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

The Model fitting parameters group by number of HPCA (Table 84): The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for whole brain.

| HPCA | MSPE | | Correlation | |
|---|---|---|---|---|
| | Train | Test | Train | Test |
| **1** | 0.94(0.409,0.942) | 0.936(0.542,0.938) | 0.245(0.242,0.719) | 0.261(0.253,0.642) |
| **2** | 0.57(0.203,0.947) | 1.023(0.987,1.057) | 0.571(0.228,0.893) | 0.153(0.134,0.377) |
| **3** | 0.53(0.52,0.844) | 0.833(0.72,0.981) | 0.692(0.363,0.712) | 0.407(0.166,0.548) |
| **4** | 0.967(0.958,0.975) | 0.977(0.968,0.978) | 0.178(0.154,0.209) | 0.151(0.149,0.179) |
| **5** | 0.98(0.98,0.98) | 0.962(0.96,0.968) | 0.136(0.136,0.136) | 0.206(0.199,0.213) |
| **6** | 0.978(0.959,0.979) | 0.983(0.982,0.992) | 0.144(0.141,0.2) | 0.126(0.111,0.128) |
| **7** | 0.982(0.982,0.983) | 0.987(0.986,0.987) | 0.129(0.127,0.13) | 0.114(0.11,0.116) |
| **8** | 0.984(0.984,0.984) | 0.98(0.98,0.981) | 0.123(0.123,0.123) | 0.138(0.133,0.139) |
| **9** | 0.986(0.981,0.986) | 0.989(0.986,0.989) | 0.114(0.112,0.132) | 0.098(0.098,0.113) |
| **10** | 0.986(0.971,0.987) | 0.989(0.989,0.999) | 0.112(0.106,0.167) | 0.099(0.078,0.099) |
| **11** | 0.968(0.967,0.983) | 1.008(0.988,1.017) | 0.177(0.125,0.178) | 0.088(0.067,0.107) |
| **12** | 0.976(0.968,0.982) | 0.989(0.984,1.004) | 0.15(0.129,0.176) | 0.101(0.084,0.123) |
| **13** | 0.979(0.976,0.985) | 0.981(0.98,0.984) | 0.141(0.119,0.15) | 0.137(0.131,0.139) |
| **14** | 0.989(0.981,0.989) | 0.985(0.984,0.987) | 0.101(0.101,0.132) | 0.121(0.115,0.124) |

Table 82. The median (first quantile – third quantile) of the Mean Square Prediction Error (MSPE) and Correlation in 10 iterations group by Train and Test and the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

| HPCA | Time (s) | | |
|---|---|---|---|
| | **User** | **System** | **Elapsed** |
| **1** | 179.165(177.64,181.667) | 0.095(0.058,0.14) | 179.375(177.805,181.818) |
| **2** | 193.11(191.085,197.035) | 0.075(0.047,0.102) | 193.295(191.245,197.272) |
| **3** | 299.895(289.92,304.407) | 0.115(0.102,0.155) | 300.145(290.225,304.74) |
| **4** | 288.595(285.35,295.878) | 0.1(0.093,0.118) | 288.815(285.642,296.093) |
| **5** | 309.11(305.035,310.622) | 0.12(0.087,0.207) | 309.585(305.352,310.99) |
| **6** | 313.925(313.377,316.307) | 0.11(0.09,0.17) | 314.19(313.628,316.625) |
| **7** | 360.065(357.067,362.037) | 0.135(0.105,0.193) | 360.38(357.598,362.325) |
| **8** | 352.785(351.688,356.355) | 0.115(0.102,0.155) | 353.01(352.045,356.623) |
| **9** | 393.765(389.928,398.733) | 0.165(0.135,0.19) | 394.14(390.705,399.075) |
| **10** | 389.105(384.775,397.482) | 0.15(0.14,0.178) | 389.47(385.157,397.832) |
| **11** | 447.41(439.542,451.202) | 0.17(0.14,0.22) | 447.825(439.94,451.715) |
| **12** | 433.06(428.905,437.673) | 0.16(0.11,0.248) | 433.295(429.29,438.31) |
| **13** | 483.605(441.205,494.715) | 0.155(0.15,0.208) | 484.065(441.463,495.143) |
| **14** | 417.03(414.825,422.892) | 0.18(0.17,0.215) | 417.39(415.175,423.237) |

Table 83. The median (first quantile – third quantile) of the Time (user-system-elapsed) in 10 iterations group by the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

| HPCA | Min_Error | Optimum | | | | | |
|---|---|---|---|---|---|---|---|
| | | **index** | **K** | **Tau** | **Lambda** | **Eta** | **Kappa** |
| **1** | 13.443(13.07,13.457) | 4(4,5.75) | 1(1,1.75) | 55(0.325,100) | 0.35(0.125,0.4) | 0(0,0) | 1(0.25,1) |
| **2** | 13.367(10.934,13.412) | 12(10.5,12) | 1.5(1,2) | 100(25.75,100) | 0.4(0.25,0.4) | 0.01(0.01,0.01) | 0.5(0,75.25) |
| **3** | 12.68(12.381,13.509) | 11.5(11,12) | 2(1,3) | 100(32.5,100) | 0.4(0.325,0.4) | 0.01(0.01,0.01) | 0.005(0,0.753) |
| **4** | 13.761(13.745,13.771) | 2.5(1.25,9.75) | 1(1,1.75) | 5.5(0.325,77.5) | 0.25(0.125,0.375) | 0(0,0.008) | 100(1,100) |
| **5** | 13.783(13.761,13.82) | 6(1.25,9) | 1(1,1) | 0.1(0.1,0.1) | 0.1(0.1,0.1) | 0.005(0,0.01) | 100(100,100) |
| **6** | 13.731(13.711,13.749) | 5.5(3,9) | 1.5(1,6) | 5.5(0.325,10) | 0.25(0.125,0.3) | 0(0,0.01) | 100(100,100) |
| **7** | 13.852(13.809,13.869) | 4(1.25,7.75) | 1(1,1) | 55(0.325,100) | 0.35(0.125,0.4) | 0(0,0) | 100(100,100) |
| **8** | 13.885(13.871,13.888) | 3.5(2,6.5) | 1(1,1) | 5.5(0.325,77.5) | 0.25(0.125,0.375) | 0(0,0) | 100(100,100) |
| **9** | 13.887(13.878,13.897) | 2.5(1,8) | 1(1,1) | 0.55(0.1,100) | 0.15(0.1,0.4) | 0(0,0) | 100(100,100) |
| **10** | 13.879(13.841,13.926) | 3(2.25,4) | 1(1,4.75) | 5.5(0.1,10) | 0.25(0.1,0.3) | 0(0,0) | 100(100,100) |
| **11** | 13.858(13.826,13.894) | 8(4,9) | 6.5(2.25,8) | 10(0.325,77.5) | 0.3(0.125,0.375) | 0.005(0,0.01) | 100(100,100) |
| **12** | 13.825(13.788,13.849) | 4(3.25,9.25) | 3.5(1.25,5.5) | 10(10,77.5) | 0.3(0.3,0.375) | 0(0,0.008) | 100(100,100) |
| **13** | 13.836(13.805,13.861) | 3(1,3.75) | 3(2,4) | 0.1(0.1,10) | 0.1(0.1,0.3) | 0(0,0) | 100(100,100) |
| **14** | 13.854(13.842,13.869) | 4(2,8.25) | 1(1,3.25) | 0.55(0.1,1) | 0.15(0.1,0.2) | 0(0,0.008) | 100(100,100) |

Table 84. The median (first quantile – third quantile) of the model fit indices in 10 iterations group by the number of hybrid principal component analysis (HPCA) for right temporal region of the brain.

### 3.2.3.8 Figures

The MSPE over Number of HPCA group by Regions: Figure 62

The Correlation over Number of HPCA group by Regions: Figure 63

The Elapsed Time over Number of HPCA group by Regions: Figure 64

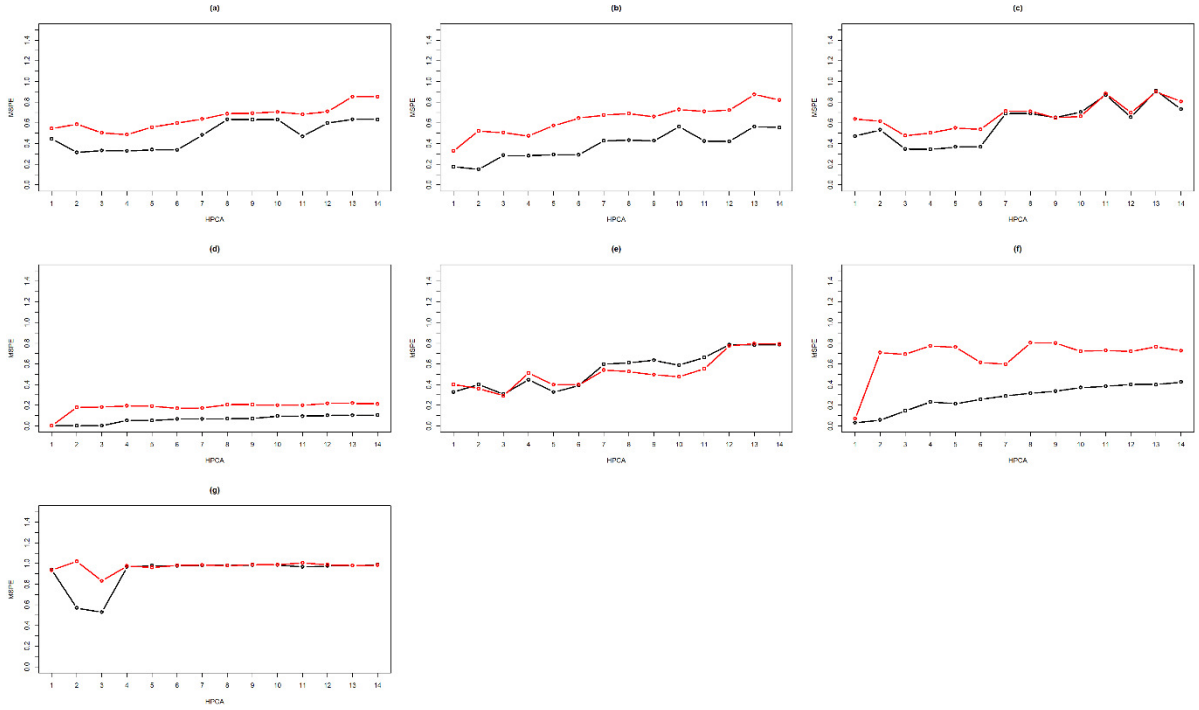



Figure 62. (a-g) Median of mean square prediction error (MSPE) for train (black solid line) and test (red solid line) in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

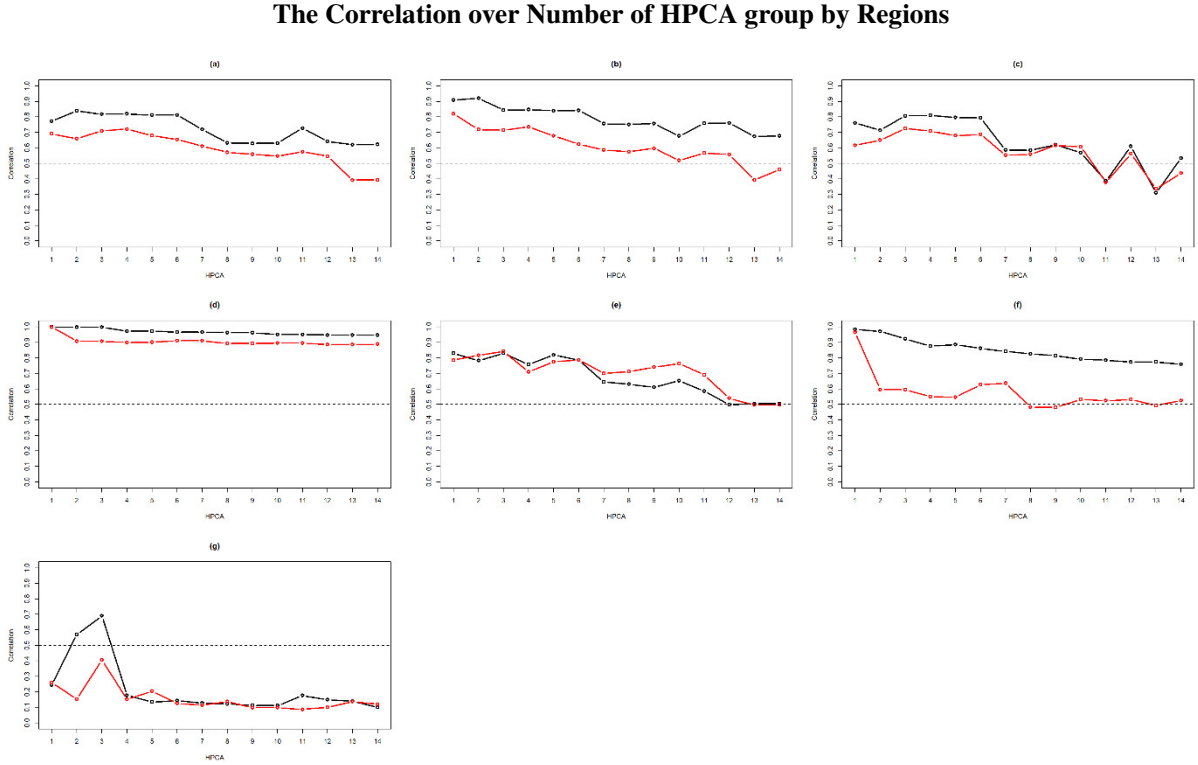



Figure 63. (a-g) Median of correlation for train (black solid line) and test (red solid line) in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

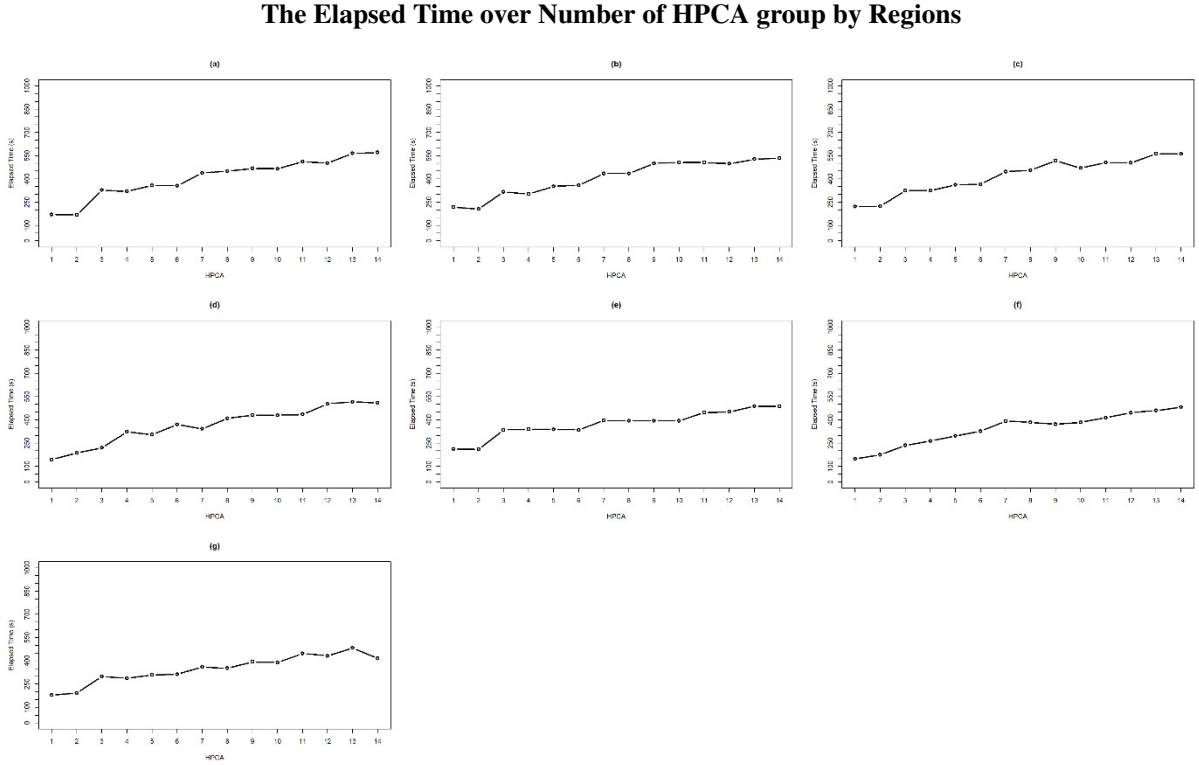



Figure 64. (a-g) Median of elapsed time in 10 iterations of (a) whole, (b) frontal, (c) central, (d) occipital, (e) parietal, (f) left temporal and (g) right temporal regions, respectively.

*3.2.4. Conclusion .*

According to the Figure 46, the MSPE is not changing in many HPCAs but some of them have lowest MSPE in training and testing datasets. For example, in the right temporal (g), the minimum MSPE is obtained with first three HPCA, but in the left temporal, the minimum MSPE is obtained with the first HPCA.

The Figure 47 shows the correlation. The highest correlation are obtained in different HPCA in different regions for both training and testing datasets.

But the elapsed time is increasing by adding HPCA for all regions.(Figure 48)

We conclude that the different number of HPCA has the best performance based on the MSPE, correlation and elapsed times. It depeneds based on the datasets. But the elapsed time is increasing for all regions.

## 4. Bayesian Simulation

### *4.1. Without HPCA*

| Without HPCA (Table A) | | | | | | | |
|---|---|---|---|---|---|---|---|
| #HPCA | Deviance | DIC | LPML | MSPE (Mean) | Correlation (Mean) | Time (user) | Time (Elapsed) |
| 1 | -11112<br>(-11157.45,-11065.91 ) | -10646.7<br>(-10689.65,-10599.83 ) | 17.03<br>(15.33,18.74 ) | 0.00038<br>(0.00033,0.00044 ) | 0.9993<br>(0.9991,0.9995 ) | 7.93<br>(7.81,8.13 ) | 49<br>(48.59,49.63 ) |
| 2 | -11129.6<br>(-11175.2,-11078.12 ) | -10672.05<br>(-10718.45,-10623.8 ) | 17.14<br>(15.73,19.59 ) | 0.00044<br>(0.00036,0.00051 ) | 0.9993<br>(0.9991,0.9994 ) | 8.27<br>(8.14,8.42 ) | 49.89<br>(49.11,51.37 ) |
| 3 | -11133.69<br>(-11175.57,-11088.06 ) | -10706.25<br>(-10764.33,-10652.8 ) | 16.81<br>(14.6,19.39 ) | 0.0004<br>(0.00035,0.00047 ) | 0.9994<br>(0.9992,0.9995 ) | 15.59<br>(8.53,15.98 ) | 56.63<br>(50.5,58.01 ) |
| 4 | -11142.12<br>(-11178.3,-11089.92 ) | -10723.85<br>(-10798.4,-10675.18 ) | 14.91<br>(12.96,16.64 ) | 0.00038<br>(0.00033,0.00044 ) | 0.9994<br>(0.9992,0.9996 ) | 9.32<br>(8.94,11.48 ) | 51.79<br>(51.12,55.78 ) |
| 5 | -11153.12<br>(-11186.71,-11095.58 ) | -10754.8<br>(-10828.25,-10696.43 ) | 13.91<br>(11.68,16.35 ) | 0.00034<br>(0.0003,0.00039 ) | 0.9995<br>(0.9994,0.9996 ) | 9.31<br>(9,9.95 ) | 52.42<br>(51.77,55.85 ) |
| 6 | -11161.37<br>(-11204.75,-11099.88 ) | -10762.6<br>(-10849.83,-10709.3 ) | 18.19<br>(15.85,21.02 ) | 0.0003<br>(0.00027,0.00035 ) | 0.9996<br>(0.9995,0.9997 ) | 9.96<br>(9.42,18.44 ) | 54.33<br>(52.9,62.11 ) |
| 7 | -11166.77<br>(-11204.95,-11101.98 ) | -10779.5<br>(-10857.2,-10724.48 ) | 17.51<br>(15.62,18.95 ) | 0.00029<br>(0.00025,0.00033 ) | 0.9997<br>(0.9995,0.9997 ) | 9.9<br>(9.68,10.19 ) | 54.2<br>(53.71,55.38 ) |
| 8 | -11167.97<br>(-11207.04,-11107.69 ) | -10796.6<br>(-10865.3,-10732 ) | 18.37<br>(16.62,20.2 ) | 0.00027<br>(0.00024,0.00031 ) | 0.9997<br>(0.9996,0.9998 ) | 18.62<br>(9.91,20.92 ) | 63.64<br>(55.79,66.27 ) |
| 9 | -11172.8<br>(-11214.64,-11113.6 ) | -10819.05<br>(-10895.08,-10752.4 ) | 20.12<br>(18.65,21.28 ) | 0.00025<br>(0.00022,0.00028 ) | 0.9997<br>(0.9996,0.9998 ) | 21.16<br>(11.1,34.9 ) | 67.61<br>(58.86,80.88 ) |
| 10 | -11172.68<br>(-11213.23,-11113.14 ) | -10835.3<br>(-10938.6,-10771.85 ) | 18.38<br>(17.39,19.98 ) | 0.00024<br>(0.00021,0.00027 ) | 0.9997<br>(0.9997,0.9998 ) | 20.32<br>(11.19,37.6 ) | 67.88<br>(58.17,84.97 ) |

Table 85. The median (first quantile – third quantile) of the model fit indices.(100 iterations)

### *4.2. First HPCA*

| First HPCA (Table B) | | | | | | | |
|---|---|---|---|---|---|---|---|
| #HPCA | Deviance | DIC | LPML | MSPE (Mean) | Correlation (Mean) | Time (user) | Time (Elapsed) |
| 1 | -20131.37 (-20135.31,-20127.99 ) | -19588.6 (-19592.63,-19585.28 ) | 29.12 (28.16,30.08 ) | 0.00015 (0.00014,0.00016 ) | 0.999996 (0.999992,0.999997 ) | 21.04 (10.49,35.67 ) | 62.43 (51.34,77.27 ) |
| 2 | -20135.13 (-20137.96,-20130.74 ) | -19876.9 (-20240.3,-19751.13 ) | 32.19 (31.57,32.95 ) | 0.00014 (0.00013,0.00015 ) | 0.999998 (0.999997,0.999998 ) | 20.23 (8.28,33.97 ) | 61.44 (49.65,75.33 ) |
| 3 | -20139.53 (-20143.07,-20136.35 ) | -20460.95 (-20958.68,-20170.68 ) | 33.28 (32.33,34.33 ) | 0.00014 (0.00013,0.00015 ) | 0.999998 (0.999997,0.999998 ) | 8.66 (8.25,27.33 ) | 51.32 (50.26,69.98 ) |
| 4 | -20138.93 (-20141.34,-20134.87 ) | -20609.8 (-20801.55,-20390.98 ) | 28.83 (27.62,29.78 ) | 0.00014 (0.00013,0.00015 ) | 0.999998 (0.999998,0.999998 ) | 8.61 (8.27,17.7 ) | 51.53 (50.64,59.94 ) |
| 5 | -20141.05 (-20145.43,-20137.68 ) | -21110.45 (-21398,-20944.03 ) | 29.17 (27.9,30.7 ) | 0.00013 (0.00012,0.00014 ) | 0.999998 (0.999998,0.999999 ) | 9.01 (8.63,18.06 ) | 52.49 (51.63,60.49 ) |
| 6 | -20143.45 (-20146.14,-20140.02 ) | -21428.4 (-21641.08,-21174.48 ) | 31.16 (29.65,32.3 ) | 0.00013 (0.00012,0.00014 ) | 0.999999 (0.999998,0.999999 ) | 10.08 (8.79,19.48 ) | 55.03 (52.52,63.02 ) |
| 7 | -20143.42 (-20146.81,-20140.06 ) | -21404.25 (-21666.03,-21188.78 ) | 29.57 (28.33,31.13 ) | 0.00013 (0.00012,0.00013 ) | 0.999999 (0.999999,0.999999 ) | 14.51 (9.08,23.75 ) | 59.44 (53.35,68.77 ) |
| 8 | -20147.25 (-20150.92,-20143.65 ) | -21165.15 (-21296.8,-21012.43 ) | 29.88 (28.02,31.33 ) | 0.00012 (0.00012,0.00013 ) | 0.999999 (0.999998,0.999999 ) | 15.71 (8.77,26.89 ) | 60.96 (54.38,72.56 ) |
| 9 | -20147.86 (-20151.19,-20144.29 ) | -21414.9 (-21560.13,-21242.43 ) | 32.39 (30.82,33.63 ) | 0.00012 (0.00011,0.00013 ) | 0.999999 (0.999999,0.999999 ) | 15.9 (8.85,27.47 ) | 62.43 (55.22,73.67 ) |
| 10 | -20145.8 (-20149.02,-20142.56 ) | -21416.45 (-21632.78,-21149.28 ) | 29.88 (28.26,31.32 ) | 0.00012 (0.00011,0.00013 ) | 0.999999 (0.999999,0.999999 ) | 16.1 (8.44,30.86 ) | 63.49 (55.98,78.22 ) |

Table 86. The median (first quantile – third quantile) of the model fit indices.(100 iterations)

### *4.3. All HPCA*

| All HPCA (Table C) | | | | | | | |
|---|---|---|---|---|---|---|---|
| #HPCA | Deviance | DIC | LPML | MSPE (Mean) | Correlation (Mean) | Time (user) | Time (Elapsed) |
| 1 | -19937.82<br>(-19948.3,-19929.46 ) | -19396.45<br>(-19407.48,-19388.33 ) | -37.71<br>(-42.66,9.45 ) | 0.13847<br>(0.00088,0.16171 ) | 0.3917<br>(0.28117,0.9978 ) | 15.52<br>(8.27,30.54 ) | 56.26<br>(49.67,72.09 ) |
| 2 | -19962.29<br>(-20000.84,-19937.26 ) | -19424.95<br>(-19468.63,-19404.8 ) | 21.26<br>(16.52,25.09 ) | 0.00045<br>(0.00034,0.0006 ) | 0.99913<br>(0.99862,0.99938 ) | 9.39<br>(8.28,17.4 ) | 52.37<br>(49.73,61.48 ) |
| 3 | -20023.1<br>(-20044.4,-19985.27 ) | -19489.35<br>(-19528.45,-19464.85 ) | 25.14<br>(22.4,27.53 ) | 0.00033<br>(0.00029,0.0004 ) | 0.99945<br>(0.99921,0.9996 ) | 9.3<br>(8.27,17.24 ) | 51.77<br>(50.24,59.81 ) |
| 4 | -20129.8<br>(-20133.02,-20127.03 ) | -19590.25<br>(-19593.4,-19586.98 ) | 28.79<br>(27.91,29.55 ) | 0.00016<br>(0.00015,0.00017 ) | 0.99997<br>(0.99994,0.99999 ) | 17.82<br>(8.76,24.41 ) | 60.24<br>(51.55,68.1 ) |
| 5 | -20131.72<br>(-20135.6,-20127.7 ) | -20294.05<br>(-20858.55,-20067.8 ) | 25.74<br>(24.44,27.03 ) | 0.00016<br>(0.00014,0.00017 ) | 0.99997<br>(0.99995,0.99999 ) | 15.48<br>(8.35,25.53 ) | 58.4<br>(51.94,68.29 ) |
| 6 | -20131.2<br>(-20135.39,-20127.29 ) | -20434.5<br>(-20663.78,-20188.93 ) | 29.03<br>(27.56,30.63 ) | 0.00015<br>(0.00014,0.00016 ) | 0.99997<br>(0.99995,0.99999 ) | 15.34<br>(8.37,26.37 ) | 58.91<br>(52.46,70.08 ) |
| 7 | -20135.81<br>(-20138.76,-20131.51 ) | -20792.2<br>(-21114.08,-20551.7 ) | 28.35<br>(27.02,29.9 ) | 0.00015<br>(0.00014,0.00016 ) | 0.99998<br>(0.99996,0.99999 ) | 13.29<br>(8.26,25.32 ) | 58.72<br>(52.59,70 ) |
| 8 | -20139.32<br>(-20142.71,-20135.15 ) | -20876.3<br>(-21079.25,-20697.53 ) | 27.63<br>(25.5,28.84 ) | 0.00014<br>(0.00013,0.00015 ) | 0.99998<br>(0.99996,0.99999 ) | 14.29<br>(8.33,19.65 ) | 59.59<br>(53.82,65.13 ) |
| 9 | -20140.15<br>(-20143.75,-20135.61 ) | -20983.65<br>(-21189.83,-20796.15 ) | 30.76<br>(29.14,32.12 ) | 0.00014<br>(0.00013,0.00014 ) | 0.99998<br>(0.99996,0.99999 ) | 15.86<br>(12.52,23.74 ) | 62.36<br>(58.6,70.75 ) |
| 10 | -20138.89<br>(-20141.58,-20135.02 ) | -20952.45<br>(-21105.6,-20787.9 ) | 28.17<br>(26.36,29.72 ) | 0.00014<br>(0.00013,0.00015 ) | 0.99998<br>(0.99996,0.99999 ) | 19.17<br>(12.81,27.24 ) | 67.27<br>(60.08,75.2 ) |

Table 87. The median (first quantile – third quantile) of the model fit indices. (100 iterations)

## REFERENCES

1. Walz, J.M., et al., *Simultaneous EEG–fMRI reveals a temporal cascade of task-related and default-mode activations during a simple target detection task.*, Neuroimage, 2014. 102: p. 229-239.