Cognitive Neuroscience & fMRI

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1. Introduction

Brain is an important organ of human. In our lives, we will use our brain everyday, even when we are sleeping. As it will affect our lives deeply, studying about that becomes a hot topic.

The final purpose of this project is to investigate two things. Firstly, it wants to find out which part of the brain will be used when a person memorize a character. Second, it wants to find out whether there is difference between memorizing characters with same syllable and characters with different syllable.

Before we get into the final purpose, the experiment should be decided first. A program, which is written by Inquisit, is used to perform a task in order to study the two things stated before. After finishing the program, a test of the experiment will perform. And the experiment will be carry with the functional magnetic resonance imaging (fMRI). After the testing, the program can be improved. And the data from the testing were analysed by a program in MatLab, Statistical Parametric Mapping (SPM). To analyse the data, a pre-processing needs to be done first. And the method of pre-processing will be found out in this project.

2. Experimental

2.1 Subject
People who are native Mandarin speaker are invited to join the experiment. They must be people who can recognize Chinese character and know how it pronounced. Moreover, people came from same area are preferred.

2.2 Characters chosen

Characters, which are common use, will be chosen because many people will know their pronunciation. Also, characters have one pronunciation only will be preferred. As we will group the characters which have the same pronunciation together, a character which has a same pronunciation with more than five characters will be chosen.

2.3 Data set of characters

To perform the experiment, a programming language called Inquisit was used. Firstly, we derived the characters into two groups, “same syllable” and “different syllable”. In “same syllable”, characters were divided into subgroups. Characters in each subgroup had the same pronunciation. In “different subgroups”, characters were grouped randomly. Within each subgroup, pronunciation of the characters should be different.

2.4 Program

After finishing the grouping of characters, a program is written to perform the experiment. The experiment contains 8 blocks where each block contains 10 trials and 1 trial lasts for 30s. In this 30s, the first second was used for the fixation, which was a black cross place in a certain position and it helped to keep the subject’s eyes in a certain position of the screen. In the next five seconds, five different characters were displayed and the subject was asked to memorize these five characters. Then it will have another 9 seconds for fixation. After the fixation, a character was displayed. It may be a character shown before, or it may be a new character. Then, subject was asked to give a response within these 2 seconds. After giving a response, 13 seconds long fixation was shown.

3. Results

3.1 The method of pre-processing

3.1.1 Slice timing

The brain was scanned by dividing it into a number of slices. A few milliseconds were taken to scan each slice. Thus, a time difference was existed between the first and last slice.
Because the signal of each slice was assumed to be taken at the same time, signal needed to be shifted.

3.1.2 Realignmnent

During the scanning of the brain, subject may move his/her head due to the respiration and pulsation. Realignment is a motion correction process. It takes the first image to be the reference image. Then, other images are compared with the reference image. The positions of other images are adjusted until they are close to the reference image.

3.1.3 Coregistration

Coregistration means moving the functional image, which is the image of the brain when performing the task, by translation and rotation. It will find a position, which most part of the functional images, can match the structural image. Structural image means the image of the brain when no task is performed. Then move the functional images to that position.

3.1.4 Spatial Normalization

Template is a standard image used in psychology. As the subjects have different size of head, we cannot compare the images easily. Thus, it’s better to rescale them into a certain size. Spatial normalization means adjusting the size of functional images and structural images to the same scale with the template.

3.1.5 Smoothing

Because the images of subjects’ heads have different shape with the template, the spatial normalization cannot register them exactly. Spreading out needed in order to reduce the discrepancy. And this spreading out process called smoothing.

3.1.6 Segmentation

This process is optional. Segmentation is a process to divide the image into grey matter, white matter and CSF (cerebral spinal fluid). It is performed when a brain model, which is a 3-D picture of the brain, is expected.

4. Discussion

Choosing the suitable subjects is an important task because it will affect the result directly. In this project, subjects were requested to recognize more than 90% of the characters, which were shown during the experiment. “Recognize” means it can be
pronounced when it is shown. As this is a research about studying the system of memorizing characters with same syllable and characters with different syllable, people are advised to memorize the characters by their sounds during the experiment. If people don’t know the pronunciations of the characters, they will memorize the character by their appearance instead, which will affect the result. Moreover, people came from same area will be preferred. As in China, people in different area will have different pronunciation of the same character. Their pronunciations may sound similar, but it’s not exactly the same.

Programming language of Inquisit is easy to learn. But it’s not flexible enough. It can be used to perform simple experiment only. In this project, Inquisit may not be the most suitable programming language as the code is complicated for performing this task.

Testing of the experiment is an important step in a project. Without testing, factors, which will affect the result, will not be found. For instance, characters having similar appearance will help for memorizing. Thus, it is suggested that avoiding put two characters, which look like each other, together. After testing, experiment or data set of characters will be improved. And a more accurate result will be obtained.

To find out the number of character which subjects can recognize, a questionnaire was provided after the experiment. The subjects were asked to circle the character they don’t know. If a character was found to be new to many subjects, another character will replace that.

SPM is powerful and user friendly. To perform the steps of pre-processing, a few buttons are pressed. Then the SPM will finish that automatically. As the program may not be suitable for all images, understanding the theory will become important. To realign, coregister, normalize the images, matrix was used. To smooth the images, Gaussian was used.

The pre-processing process should be started at slice timing. Then the realignment, coregistration and normalization were performed. Finally, smoothing was used. If the image will be used to make a brain model, segmentation needed. Then order is obtained by trial and error. Some suggesting orders are provided by web and by the producer of SPM. They also provided two data sets. To find out the most suitable order, the data sets were used to test. By concluding the result of trying orders provided by web and the understanding of each process, the order stated before was obtained.

5. Conclusion
The system of memorizing characters with same syllable and characters with different syllable was studied in this project. To achieve this purpose, an experiment should be decided. Firstly, subjects and characters were chosen carefully. Then, a program written by Inquisit was used to perform the task. After obtaining the data, SPM was used to analyse the data. To analyzing the data correctly, the order of pre-processing needed to be found. After a series of testing, the order was found to be slice timing, realignment, coregistration, normalization and smoothing.