Imaging Experiment of Brain Cognitive Activity Based on EEG and Its Philosophical Influence

Fang Ren*

ABSTRACT

Mental workload estimation has been under extensive investigation over the years, because the capability of monitoring the cognitive workload enables the prevention of cognitive overloading and improvement of workplace safety. Electroencephalogram (EEG) signals has been found to be an objective and non-intrusive measure of mental workload. However, the evaluation of cognitive workload based on single-trial EEG data, which is an essential step towards real-time workload monitoring and brain-computer interface, has been a major challenge. The philosophical basis is the similarity of technical images, the probability of dependence on image shape is similar; the ethical basis is that the experimenter's voluntary former is the external foundation; the latter two constitute the intrinsic foundation. It distinguishes the objects and concepts in the whole philosophical tradition In particular, it poses a challenge to the proposition of phenomenology that "there is a fundamental distinction between the matter's intention and the concept's intention", so it has to face the problem of the philosophy of science of phenomenology.

Key Words: Imaging Experiment, Brain Cognitive Activity, Electroencephalogram Signals, Philosophical Influence

DOI Number: 10.14704/nq.2018.16.5.1271 **NeuroQuantology 2018; 16(5):719-724**

Introduction

In the history of philosophy, the distinction between things and ideas has become a very important issue. The tradition of knowledge gives distinction and analysis from the source and the nature of proposition. The tradition of phenomenology illustrates the difference from the output of intention behavior. For example, Husserl illustrates the distinction between the concept of pointing to individual "triangle" and pointing to universal triangle from the perspective of intention experience. The tradition of phenomenology illustrates the difference of the two from the output of intentional behavior. For example, Husserl illustrates the distinction between the concept of triangle pointing to individuals and that pointing to universal triangle from the perspective of intentional experience. But with the development of brain science and image technology, these scientific experiments have proven that the two propositions are similar. Patrick Supez, professor of philosophy of science at Stanford University, is a typical representative. This paper will begin with the imaging experiment of Suppes and analyze the foundation of this experiment and its philosophical influence (Kalpana *et al*., 2013; Sun *et al*., 2016; Du *et al*., 2013).

EEG imaging experiment

Experimental content

On the basis of the mature imaging technology, Suppes made three related experiments by using the nuclear magnetic resonance technology. In 1996, we did the MEG experiment at the Scripps Institute in San Diego, California, especially with the help of Lui Zhonglin, who had just received his doctorate with Sam Williamson

Corresponding author: Fang Ren
Address: Xi'an Jiaotong University, Xi'an 710049, China
e-mail ✉ wichana@163.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 5 March 2018; **Accepted:** 4 April 2018

and Lloyd Kaufman of New York University. His three experiments are as follows: The first experiment is aimed at invariance among subjects. The experiment is designed for nine subjects. The tester provides 48 sentences about European geography to nine subjects and asks the subjects to judge whether the sentences are true or false. The EEG is recorded when they heard the sentences or read the sentences displayed word by word on a computer screen. One of the sentences is "The capital of Italy is not Paris, and Warsaw is the largest city in Austria." The data of five of the subjects are averaged to form a prototype of the 48 sentences. The data of the other four subjects are recorded to form an average test sample of each sentence. Results: The EEG did not change among the subjects (Colinart *et al*., 2013; Song *et al*., 2016; Du *et al*., 2018).

The second experiment is to present 100 different geographical sentences to the subjects. The experiment focuses on the significant results of a subject (S32) correctly recognizing 93 sentences from 100 sentences. The results show that the best recognition rate achieved by a single subject is 93%, that's, 93 correct recognition results can be identified from 100 test samples. The results showed that the subjects could correctly recognize 93 sentences (Daud and Sudirman, 2017).

The third experiment is a visual image experiment, which tests the difference in brain activity image among subjects seeing the same sentence and hearing the same sentence. The results show that visual images of simple shapes (circles or triangles) are very similar to brain images produced by corresponding words (Mazher *et al*., 2016).

Experimental result

We collectively refer to these three different experiments as the Suppes experiment. The overall result of this experiment shows that "the necessary and the main empirical result of the representation may be the only result obtained at present." As far as its philosophical influence is concerned, the most important of these three experiments is Experiment 3. There are two reasons for this: first, from the point of view of the problem concerned in the experiment, Experiment 1 mainly studies the differences of EEG in the process of judging and recognizing sentences by the subjects; Experiment 2 mainly studies the cases of correctly recognizing sentences by the subjects, and the problems that these two experiments focus on are relatively small and not universal; the problems studied in Experiment 3 are the differences between things and concepts of the main problems in the history of philosophy, which is firstly expressed in Berkeley and secondly in Husserl's phenomenology: Is there any difference between the two behaviors when a person sees an object and hears the name of the same of the same object? Secondly, from the experimental method, Experiment 3 is to study the above-mentioned problems by EEG contrast, that's, drawing a conclusion by comparing the EEG images produced by the two psychological activities (Alexiou *et al*., 2009; Tang and Chen, 2016).

Therefore, the philosophical influence of this experiment referred to in this paper is viewed from a larger philosophical perspective, especially with the help of phenomenology to analyze how this experiment affects philosophy. The concrete analysis will be unfold later. Before unfolding, it is necessary to understand the basic conclusion of Experiment 3: The results of this experiment are "EEG generated by simple shapes and color blocks are surprisingly similar to those produced by their oral names." This conclusion, together with extensive psychological studies of auditory and visual memory, supports the answers to the conjectures of Berkeley and Hume. The results of the experiments that Suppes has proposed are astounding: The similarity between auditory brain images and visual brain images results in a complete shock to the distinction established by Husserl: The difference between the intention of a thing and the intention of an idea. The result means that when I look at things that are "triangles," I will definitely produce the corresponding cognitive image A in the brain, and when I hear the word "triangle," the brain also produces the corresponding cognitive image B, and there is a lot of similarity between A and B". This means that this experiment does not confirm the distinction between the two in Husserl's above proposition, but criticizes his proposition. How should we evaluate the Suppes experiment itself and its philosophical influence?

Foundations of the experiment

Technical basis

The technical foundation of the Suppes experiment is modern imaging technology, especially imaging technology related to the

brain. The scientific philosopher Suppes described the four methods involved in his experiments. Currently, the four main ways to observe brain activity are easy to describe: The first method is the classic electroencephalogram (EEG) observation already mentioned, which is important because it has a time resolution of at least one thousandth of a second. The second method is modern magnetic field observation, not electric field observation, which is done under the heading of magnetoencephalogram (MEG).

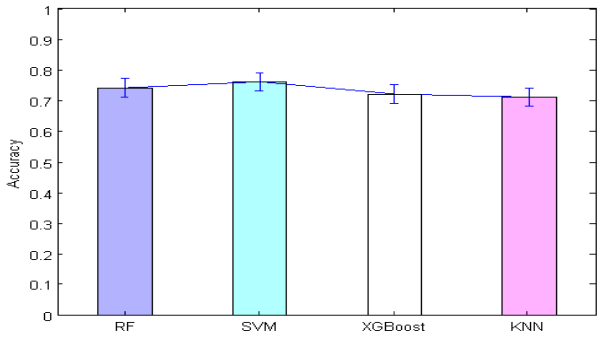

Figure 1. Classification accuracy using Power features

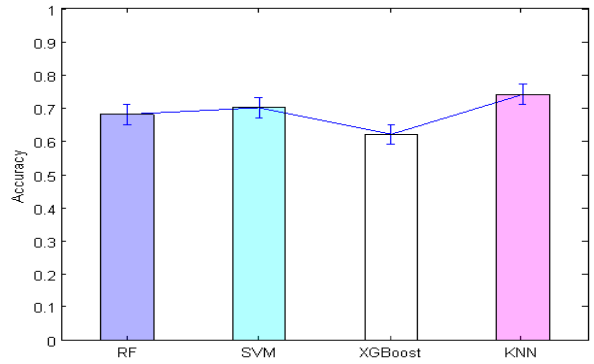

Figure 2. Classification accuracy using CSP features

This method also has the same time resolution of approximately one thousandth of a second. The third method is positron emission tomography (PET), which is good for looking at the location of brain activity, but with only one second of time resolution. Finally, the most popular method at present is functional magnetic resonance imaging (fMRI), which has the greatest advantage of observing energy absorption where it is well located in the brain, but unfortunately it also has a time resolution of no less than one second. In addition to these four methods, there are many other methods such as Evoked Potantial, TMS, Lessions, and Class History, all of which are methods of measuring the nervous system. The results of classification accuracy using Power features and CSP features as shown in following figure 1 and figure 2. Suppes' experiment mainly uses two kinds of imaging techniques: electroencephalogram (EEG) and magnetoencephalography (MEG).

The brain imaging techniques referred to by Suppes have bases. According to neurobiologists, the related techniques are among the four types mentioned above, but their emphases are slightly different. "

However, there are many problems in the electroencephalogram (EEG) and magnetoencephalography (MEG) techniques adopted by Suppes. Images from traditional scanning techniques show that the brain is not really the brain. What we see is the shadow of the surface of the brain. The results of classification accuracy using DWT features as shown in figure 3. In 2012, Professor Gane Witden of Harvard University said, with the help of color images from a new nuclear magnetic resonance technique, they were able to really understand for the first time the neural pathways of the human brain's 100 billion cells and how the brain works. So, the key problem with these brain imaging techniques: What is the object being imaged, the brain itself or the shadow of the surface of the brain?

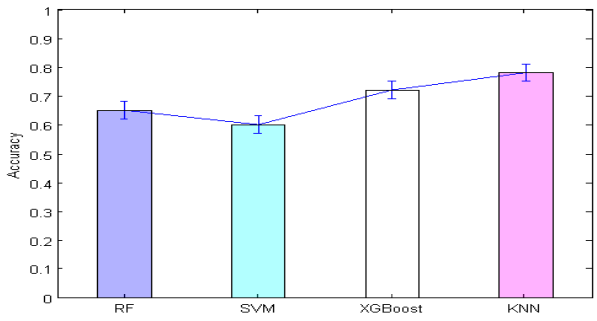

Figure 3. Classification accuracy using DWT features

Philosophical foundation

The philosophical foundation of Suppes' experiment is image similarity. How to understand image similarity? Is it the similarity between things and image objects? As in Experiment 3 above, when the subjects saw a blue object and heard the name of the blue object, and saw the triangle and heard the triangle, two similar cognitive images appeared. How to understand this similarity? First of all, the similarity of images in Suppes' experiment is statistically similar, not intuitively similar. This is very obvious in his experimental illustration. This

image is the result of statistics. So, the scientific similarity takes the place of intuitive similarity. Secondly, this similarity is the expression of the similarity of empiricism, and is an approximate coincidence between a brain image generated by a visual image and a brain image formed by hearing from the point of view of coincidence of different images. Finally, in essence, the problem of image similarity proposed by Suppes is more dependent on the shape of the image. If phenomenology reveals us that "every identity is related to a kind, and the thing to be compared belongs to this kind." If two things are identical in form, then the kind of the related form is the identical thing; if they are identical in colour, then the kind of the related form is the identical thing. Identity is the relation of objects belonging to the identical kind. Then, that image shape is the identical thing becomes the phenomenological setting in Suppes' experiment. Without this setting, all conclusions of his comparison will lose ground. The results of classification accuracy using DWT features as shown in figure 4.

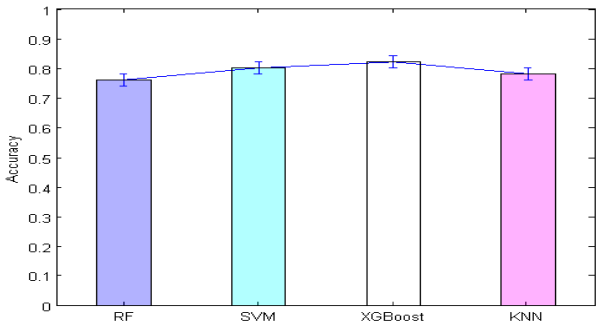

Figure 4. Classification accuracy using Power+CSP features

Ethical foundation

The ethical foundation of the experiment also needs to be explained, which is precisely what he did not pay attention to. The security, the accuracy of imaging, the privacy, and the non-medical application are several important epistemological and ethical problems faced by brain imaging technology. Of course, in the Suppes' experiment, in addition to the above ethical issues, it is more important that this experiment is subject to the subject's voluntariness, which is the basis of the experiment, during which a strong claustrophobia, psychological pressure and worry may take place, and it's unknown that to what extent these psychological activities will affect the results of the experiment. The ethical foundation cannot deny the influence of the conclusion of this experiment. In addition, it is better to analyze whether these influences are effective or not by focusing on the internal logical basis, such as the similarity of images on the basis of empiricism, which the experiment relies on, the results of classification accuracy using Power + DWT features as shown in figure 5.

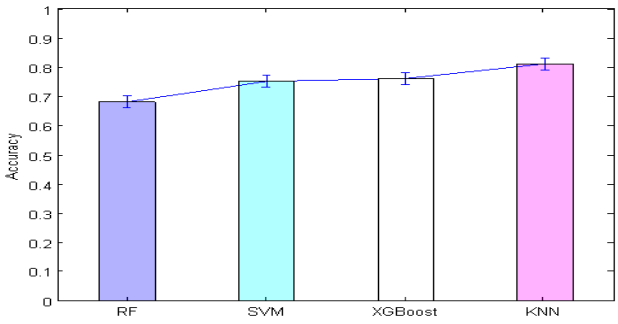

Figure 5. Classification accuracy using Power+DWT features

Finally, Suppes' experiment is supported by cognitive science. From the perspective of cognitive science, hearing and seeing are two different ways of perceiving the world. Hearing is the processing of signals in the basement membranes of hair cells and cochlea, and the cochlea sends this information in the form of nerve signals to the inferior colliculus and cochlear nucleus. The information is then transmitted to the medial geniculate body of the thalamus and reaches the primary auditory cortex. Vision is the light-sensitive cells on the retina that convert light into neural signals that are transmitted to the visual cortex.

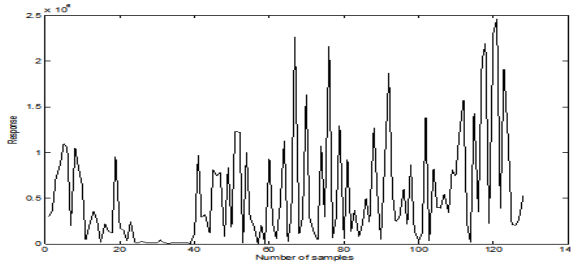

Figure 6. EGG test result for one tester

So, this means that the comparative study of the two cognitive styles is scientifically sound, because only the comparative study of two different objects is meaningful. Suppes' experiment is just like this, and it regards the auditory object as the result of auditory behavior and the visual object as the result of visual behavior. There is a strict boundary between the

two. However, this is his problem, that's, the phenomenon of synesthesia in cognitive science poses a great challenge to him. What we call synesthesia is that we can experience an object in many ways, EGG test result for one tester as shown in figure 6.

Changes in the concept of differentiation

Concrete problems

Plato established the distinction between "things and the concept of things" and "things and the images of things" earlier. In the third volume of *Utopia*, he once described the relationship between things, images of things and ideas of things. "One is a natural bed, and I think we might say that it is made by God, and the next is made by a carpenter, and the other by a painter. Therefore, the three kinds of beds are made by the painter, the carpenter, and the god." Imitation became a concept that he described the relationship between these three kinds of beings. In the Middle Ages, scholars paid close attention to the relationship between things and their concepts, thus forming the relationship between personality and commonness, individuality and generality in philosophy, namely, the tradition of epistemology. In the above-mentioned tradition, the things themselves and the concept of things have obtained the fundamental legitimacy status. Among them, Heidegger clearly revealed the question of the legitimacy of things, such as his works What are Things (1937) and Things (1951); so is especially the legitimacy of ideas, EGG test results as shown in figure 7.

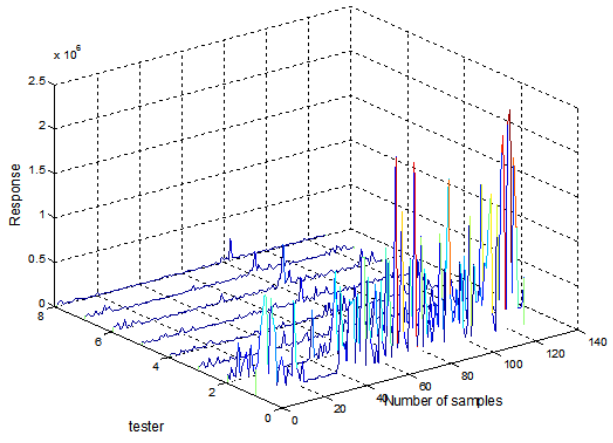

Figure 7. EGG test results

During the specific solution process, we will find a lot of interesting ways. In the face of the relationship between things and ideas, there is a controversy over whether things and ideas are completely different. Ancient and modern philosophers thought that the general truth is an idea and has nothing to do with things, but Berkeley criticized it in *An Essay Towards a New Theory of Vision*. He pointed out: "All general truths are about universal abstract ideas, which is indeed a creed of modern philosophers and ancient philosophers; I have experienced repeated efforts and pains to consider the general idea of understanding triangles, and I have found that such general idea is totally incomprehensible." Hume accepted the criticism.

Before the birth of phenomenology, the distinction between things and the concept of things was made in the ontological sense. After the appearance of phenomenology, this direction has been changed and began to distinguish the two from the intentional act itself. The object itself is related to the perceptual activity of "seeing," such as I see a tree and see a triangle, and the idea is related to the perceptual activity of "hearing," such as I hear the different pronunciations of "tree." This is the distinction between the intention of seeing an object (thing) and the concept intention of hearing an object. The values Features of Power + CSP and Power + DWT as shown in table 1.

Table 1. The values Features of Power + CSP and Power + DWT

Features	RF	SVM	XGBoost	KNN
Power + CSP	75	76	77	71
Power + DWT	68	70	71	76

Comparison between phenomenology and semiology

We know that phenomenology is good at distinguishing, especially the direct distinction between different conscious behaviors. "A comparative study tells us that the behavior we mean a kind is fundamentally different from that we mean an individual; whether we mean the whole thing in the latter case, or that we mean an individual part or individual characteristic on that particular thing." Husserl discusses the distinction between the two from the visual angle and the intentional behavior, and thus effectively transforms the existing problems into the intentional analysis. With the help of the intuitionistic category, he established that the intuition of things and the intuition of ideas of things are different intuitionistic forms. The intuition of things is perceptual intuition, while the intuition of ideas is categorical intuition. The characteristics of perceptual intuition are

simplicity, that's, "it gives its object in a personal and concrete way."

However, it's difficult of phenomenology to understand and grasp the distinction between "things and ideas." In contrast, semiotics has more succinctly resolved the distinction between "things and ideas." Saussure replaced the relationship between things and ideas with the problem of the signifier and the signified. According to the semiotic theory, the symbol includes the signifier and the signified, in which the signifier means the sound image of the symbol, standing for the concept in the tradition; the signified means the concept meaning of the symbol, standing for the thing in the tradition. Therefore, in the context of semiotics, the difference between things and ideas becomes the difference between the signifier and the signified. Specifically in the Suppes' experiment, the EEG pattern formed when we see "blue" mainly refers to things that appear as colors, not conceptual meanings; when we hear the expression of "blue," whether the sound is made by a computer or someone else, this is corresponding to the signifier of the symbol.

Conclusions

Husserl criticized the naturalistic-psychological tendencies of philosophy more than 100 years ago. His critique captured the crux of the issue: he thoroughly criticized the philosophical problems existing in the late 19th and early 20th centuries as interpreting philosophical problems as The trend of psychological activity. We need to face up to this practice in the field of natural science. However, the underlying implication may be: the reflection on the research method. So, if we do not rigidly adhere to the results of Supres's experiment, at least his method is noteworthy: that is, with the development of cognitive science philosophy, the study of ancient philosophical problems through the integration of brain imaging techniques. If this method is feasible, phenomenological research and even philosophical problems will emerge as a whole Turn: The philosophical problems of the early 20th century were seen as linguistic problems. Nowadays, philosophical problems are translated into technical problems, especially those solved by imaging technology.

References

Alexiou K, Zamenopoulos T, Johnson JH, Gilbert SJ. Exploring the neurological basis of design cognition using brain imaging: some preliminary results. Design Studies 2009; 30(6): 623-47.

Colinart T, Glouannec P, Pierre T, Chauvelon P, Magueresse A. Experimental Study on the Hygrothermal Behavior of a Coated Sprayed Hemp Concrete Wall. Buildings 2013; 3(1): 79-99.

Daud SS, Sudirman R. Discovering sound effect on visual memory performance based on electroencephalography. InBiomedical Engineering and Sciences (IECBES), 2016 IEEE EMBS Conference on 2016: 210-15.

Du XL, Shi Z, Peng ZC, Zhao CX, Zhang YM, Wang Z, Li XB, Liu GW, Li XW. Acetoacetate induces hepatocytes apoptosis by the ROS-mediated MAPKs pathway in Ketotic cows. Journal of Cellular Physiology 2017; 232(12): 3296-3308.

Du X, Zhu Y, Peng Z, Cui Y, Zhang Q, Shi Z, Guan Y, Sha X, Shen T, Yang Y, Li X, Wang Z, Li X, Liu G. High concentrations of fatty acids and beta-hydroxybutyrate impair the growth hormone-mediated hepatic JAK2-STAT5 pathway in clinically Ketotic cows. Journal of Dairy Science 2018; 302(18): 30029-38.

Kalpana R, Chitra M, Kalsi N, Panda R. Analysis of brain cognitive state for arithmetic task and motor task using electroencephalography signal. Signal & Image Processing 2013; 4(4): 51-59.

Mazher M, Aziz AB, Malik AS, Qayyum A. A comparison of brain regions based on EEG during multimedia learning cognitive activity. InBiomedical Engineering & Sciences (ISSBES), IEEE Student Symposium in 2015: 31-35.

Song Y, Li N, Gu J, Fu S, Peng Z, Zhao C, Zhang Y, Li X, Wang Z, Li X, Liu G. β-Hydroxybutyrate induces bovine hepatocyte apoptosis via an ROS-p38 signaling pathway. Journal of Dairy Science 2016; 99(11): 9184-98.

Sun XD, Yuan X, Chen L, Wang TT, Wang Z, Sun GQ, Li XB, Li XW, Liu GW. Histamine Induces Bovine Rumen Epithelial Cell Inflammatory Response via NF-κB Pathway. Cellular Physiology and Biochemistry 2017; 42(3): 1109-19.

Tang L, Chen MJ. Image denoising method using the gradient matching pursuit. Mathematical Modelling of Engineering Problems 2016; 3(2): 53-56.