The Brainwave Response of Optical Illusion Stimulus

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Summary
Several centuries ago the overarching obstacle in the evolution of vision was documented when George Berkeley pointed out that information in retinal images cannot be mapped unambiguously back onto their real-world sources. In this experiment, we used the EEG to analyze the brainwave dates of 2 stimuli, one can cause human optical illusion, but the other cannot. The purpose of this work was to find out the locations and mechanisms of brainwave when the human beings watch the 2D images under the optical illusion stimulus. The results showed that the responds of the optical illusion have different response time and voltage with the different coarseness at the visual area. Recognition potential (RP.) occurs in about 250ms. Key words:

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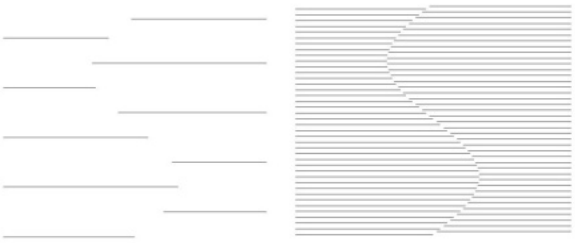
EEG，2D optical illusion, RP.

1. Introduction

As there is a sense in which all of vision is an illusion, there is some difficulty in rigorously defining 'illusion'. The resolution in our peripheral vision is roughly equivalent to looking through a frosted shower door, and yet we enjoy the illusion of seeing the periphery clearly. [1] Similarly, we are not aware of the 'edges' of our visual field, even though our angle of vision has limits; this is also an illusion of sorts. Between the information in the images that fall on the retina and their real-world sources the necessarily uncertain relationship. Since the late 1950s, the focus of visual neuroscience has been on the receptive field properties of neurons in the primary and higher-order visual pathways in experimental animals [2, 3].The same retinal projection can be generated by objects of different sizes at different distances from the observer, and in different orientations. The evolution of biological systems that generate behaviorally useful visual percepts has inevitably been guided by many demands. Among these are: (1) the limited resolution of photoreceptor mosaics; (2) the limited number of neurons available at higher processing levels; and (3) the demands of metabolic efficiency [4].

In the past, illusions were sometimes considered to be inappropriate objects of study. The nineteenth-century psychologist Oswald Kulpe expressed the intellectual climate of the era when he wrote that perceptual illusions are "subjective perversions of the contents of objective perception" [5]. This is why Exner's experiments on apparent motion[6] in 1875 did not receive a great deal of attention, until Max Wertheimer, defining the Gestalt movement almost 40 years later, re-examined apparent motion in a climate in which the study of illusions had changed[7 , 8].

To understand the mechanism of visual illusions of the human brain reflected. For our present purposes, I will review several categories of illusion that have been more traditionally explored in history and in modern neuroscience. We selected three representative 2-D images as the stimulus to research. The merits of a wholly empirical strategy of vision can be assessed by using the frequency of occurrence of stimuli to stand in for the trial and error experience in the human visual environment that would have linked retinal images to useful visually guided behaviors. By tallying up the frequency of occurrence of different targets and contexts in visual stimuli generated in nature and instantiating this information in visual system connectivity, perceptions arising on this basis should be predictable. The evidence supporting a wholly empirical theory depends on whether such predictions accord with perceptual experience. This scenario presents a problem similar to the same vision, and random retrieval of images, so the result was unpredictable.



a b

Fig.1. The Stimulus plans. Fig.1a can only see two groups of parallel lines. Fig.1b, not only can see the parallel lines, also can clearly see the S.

Moreover, visual and auditory research studies have demonstrated that the P3 component could be elicited passively and the highest amplitude around the POz point [9, 10, 11, 12]. The P3 component of ERPs represents endogenous processing of a stimulus, involving stimulus classification speed and the ability to attend to and

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evaluate a stimulus [13 , 14]. P3 latency negatively correlates with cognitive capability in normal subjects, such that shorter latencies are related to faster processing speed that reflects superior cognitive performance [15, 16, 17, 18]. As one unique component of the visual evoked potentials (VEP), visual N1 which originated in the primary visual cortex has the maximum volatility on the middle of the scalp or both side of the behind [19].

The objective of this paper is to give an analysis of EEG and visual ERP, which are based on the principle of optical illusion, to analyze the brain activities when the subjects are watching the A portion of misplaced lines stimulus, and to compare the differences between these conditions. The experiment results indicated that a bigger negative voltage appeared at occipitotemporal sites around 30 and 120 ms latencies. All of the data in this experiment exhibited that the brain activities activated by optical illusion pattern were stronger than those by the ordinary visual stimulation.

2. Materials and Methods

Ten right-handed health volunteers (including five females, mean age 22 years, range 19-25 years, no elderly people, no bad habits such as smoking [20]) with normal or corrected-to-normal vision, who have not participated in the similar experiences before, are employed to implement the experiment. In the laboratory, the room is completely closed without any noise. The volunteers put heads on the front of the stereoscope. we used Fig.1 as the stimuli. A portion of misplaced lines can be clearly identified as forming a S in the middle, even when there is no outline of S.

In the laboratory, the room is completely closed without noise and turn off the monitor, no light. The display is put on the front, where the distance 50cm of the subjects, and 2 kinds of stimuli appeared alternately. Each stimulus to prompt advance stimulus one second, then signal to stimulate the time 300ms, and then rest 1.2s (Fig. 2).

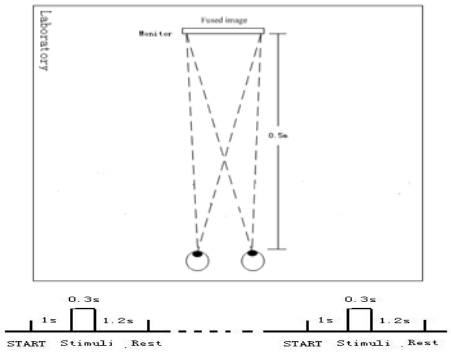

Fig. 2 The model of stereoscope and experimental flow chart

In this study, the Active Two System produced by BioSemi Inc. with 64 channels (Figure 3) is used to get the signals of the brain activity. The original data is analyzed by the EEGlab which is the toolbox for processing continuous and event-related EEG, MEG and other electrophysiological data using independent component analysis (ICA), time/frequency analysis, artifice rejection, and several modes of data visualization. For filtering the other brain wave which we unused, we insert many events randomly in every trial data and average. To analyze of the data, the first 300 ms after the presentation of each sensed 3D image is further investigated. The results of EEG will show the changes of the whole brain. For further discussion, the electrodes of the occipittemporal cortex involving Pz, and POz [21,22] will be extracted individually (Fig. 3).

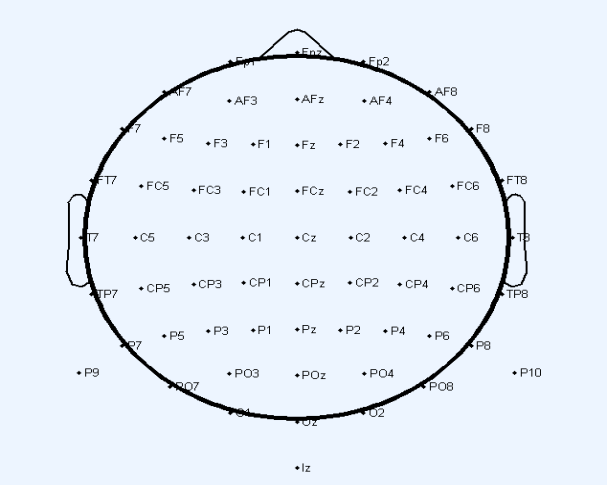

Fig. 3. the location of the electrodes

3. Results and Discussion

The ERP power changes during the optical illusion stimulus appeared in every 30 ms is shown in Fig.5a and Fig.5b, the color region and gradual change show the intensity of power in ERP spectrum, i.e. the degree of brain activity. Therefore, from Fig.4 can be seen that the power of the occipital region becomes stronger after 120 ms during the stimulus appeared, thus indicating that the visual location has a different change during the image stimulus appeared.

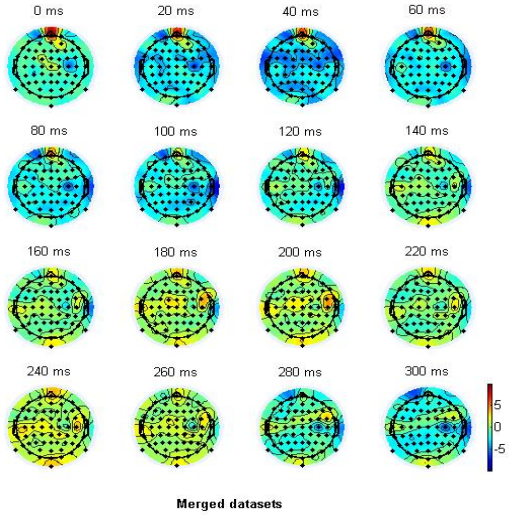

Fig. 4. The ERP results of during the stimuli a appeared 300 ms.

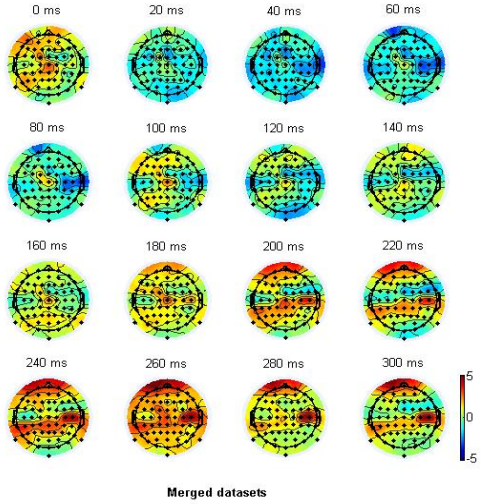

Fig. 5. The ERP results of during the stimuli b appeared 300 ms.

But from Fig.5 can be seen that the power of the occipital region becomes stronger after 80ms during the stimulus appeared, thus indicating that the visual location has a different change during the illusion stimulus appeared. This figure also shows that the occipitotemporal cortex has activities obviously between 80ms and 280 ms with the optical illusion. This suggests that the brain is beginning to greet changes at 80 ms after the stimulus happened. The human being's illusion visual responses can be considered that the C1 appeared at 80 ms during the horizontal size disparity exposed. The red color becomes deeper at 80 ms, but disappeared after 280ms.

To give more certification on this problem, the VEP of occipital region (POz, Pz) are averaged by EEGlab as shown in Fig.6a and Fig.6b. It shows that the POz and Pz have negative peaks at 30-50 ms after the stimulus (N1). But the second negative peaks are different.

InFig.6 the second negative peaks at 80ms, N2 troughs reached the max value (-3μV~ -5μV). After 60ms, the negative peaks disappeared. InFig.7 the second negative peaks at 120ms, N2 troughs reached the max value (-1μV ~ -2μV). After 150ms, the negative peaks disappeared. These are different between brain responses of these two stimuli. These are different from the results from the

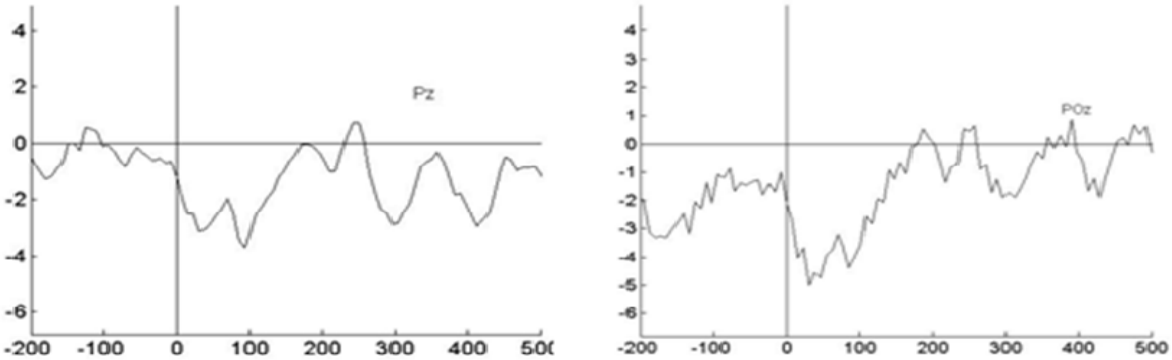

Figure 6 The visual evoked potentials (VEP) of Pz and POz during the stimuli a.

results for other 2D stimulus (like faces, objects and animals) which are observed in the previous research in EST.

From Fig.6 and Fig.7, also are found a negative peak in about 250ms which called Recognition potential (RP),

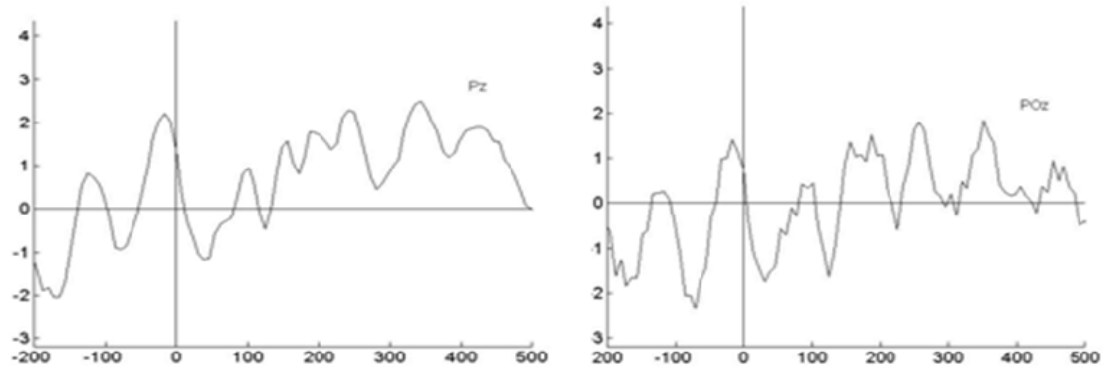

Figure 7 The visual evoked potentials (VEP) Pz and POz during the stimuli b

indicating that the illusion experiment and the Identification experiment have similarities. The "recognition potential" is an electrical response of the brain that occurs for recognizable, but not for non-recognizable, images. When a recognizable image evokes it, the more rostra of a pair of vertically oriented occipital electrodes reaches an initial positive peak at about 200-250 ms (23).Moreover, the latency of P3 reflects the evaluation and classification time for the stimuli [24, 25]. And P3 maybe have some relation with the end of processing [26, 27]. Here, the P3 responses of the no optical illusion do not have the fluctuation obviously. But the responses of the optical illusion have the positive peak of P3. So, P3 gives evidence for judging the responses of these two stimuli.

4. Conclusions

The purpose of this work was to find out the locations and mechanisms of brainwave when the human beings watch the 2D images of the optical illusion stimulus. The results showed that the responds of the optical illusion have different response time and voltage with the different coarseness at the visual area (V1). Comparing the obtained results, we found that the powers of the primary visual cortex (V1) are different. The responds of Pz and POz have negative peaks (N2) at 80ms and 120ms during the stimuli. Indicating that the illusion experiment and the Identification experiment have similarities, because we found a negative peak in about 250ms which called Recognition potential (RP). But this requires more experiments to prove.

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