

# Face recognition based on EEG

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## Abstract

Human face is a mutual understanding between our daily life is an important factor, different face will reflect different people play different, this reflects the different components of the brain waves can be interpreted in the same context, one's own photos and others brainwave ingredient photo is there a difference too, this paper respectively, from P1, N1, P2, N2 and P3 components in different modes to analyze the differences, in order to reveal the source of the photograph to stimulate brainwaves and the reasons for the difference between component .

*Keywords:* RRP components, photographs, difference

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## 1 Introduction

For a matter of concern, from the point of view EEG components, and does not care about things that are different, relevant studies were using P1, VAN and P3 for visual awareness related to the analysis of EEG, such as Pins and ffytche use of gray and white circular grating as a stimulus, the reaction according to the subjects in each experiment to control for the presentation time of stimulation, so that half of the stimulus and the other half to be conscious can not be realized, so that the collected component of the EEG were analyzed using P1; Antti Revonsuo conducted by visual masking, a variety of experimental low contrast stimulation, EEG collected to analyze the composition using the VAN; Del Cul et EEG produced after the masking method by the use of P300 was analyzed.

In a matter of concern in people, facial features unintentionally is of concern, and therefore had a lot of facial features caused by the analysis of EEG, for example, Peng Xiaohu team erp related to internal and external features of the face caused by a detailed study Zhang Yan team faces starting from the study of female faces to attract a memory-related preferences erp, erp from the constituents of the attractiveness of female faces, as early as in 1999, Keenan began to study the subjects of their faces and others the difference between the face of the reaction, the subjects were asked to identify their faces, familiar and unfamiliar faces workers strangers, they found that in upright and inverted faces two conditions for their recognition faster than familiar with the workers strangers and unfamiliar faces, which is illustrated by the familiar interpretation of self-face recognition speed advantage deficiencies.

For brain spontaneously conducted long-term thinking rather than processed reactions were analyzed using erp has a great advantage, according to the experimental

model design, the paper respectively collected 15 subjects conducted erp EEG analysis, respectively, in under the same background subjects concerned about their attention to the next photo and others conducted erp photo composition analysis, and ultimately draw attention to their photo subjects and concerns of others of different points on the photo erp ingredients.

## 2 Data processing

Experiments in BCI laboratory Jiangxi University of Technology, and the subjects is studies of Jiangxi University of Technology, subjects who were placed in a quiet shielded interior, sitting soft armchair without armrests the experiment during the experiment, subjects in accordance with the test requirements, looked at the front of the computer screen related operations, 15 experimenters were divided into three groups, each group of five people, the experimenter experimental model includes the following three mode: experimental background homosexual familiar with the situation for the next experiments have become familiar with the background to participate in sex case experiments and experimental background in the case of a stranger to participate in the experiment. Under each group mode, the experimenter is concerned were asked to do under their own photos EEG acquisition under circumstances and concerns of others situation.

During the experiment, the program will display a different stimulus picture in the middle of the computer screen, with each experiment five different photos displayed to the experimenter, photo shows the display in a random manner, each photo is displayed on the screen 1000ms after 250ms black screen appears, a single experiment took 1250ms, each experiment five photos appear randomly 370 times, the same number of each photo appears. In front of the experimenter five photos

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show the experimenter himself, including a photograph and four background photos, each photo is choose the experimenter head in the same context (shoulder above) as experimental material. Depending on the experimental background and contrast experimental purposes, each experimenter experiments include three comparative test modes:

(1) experimental background photos are familiar with gay subjects: experimental background are familiar subjects experimental model of the same sex, the subjects were made two experiments, the first subjects to their own photo as the goal, a few silent in times during the experiment own photos appear; and other subjects after the break for a second set of experiments, subjects, subject to a photo lab assistant assigned to the target, and silently count the number of times the photo appeared, two sets of experiments using the same the five photos, photos appear in a different order, when the number of subjects and the real results are given photos a difference of 5 or less, are considered valid experimental data;

(2) the experimental subjects are familiar with the background of the photo contains two gay, two subjects are familiar with the opposite sex: This experimental model is designed primarily for data results of the first experimental model, the impact of the opposite sex during the experiment comparing photos of the experimental results, experiments are divided into two groups, the first subjects to their own photo as the goal, and silently count the number of times their photos appear in the course of the experiment; and other subjects after the break for a second set of experiments subjects, subjects with laboratory assistant specify a heterosexual photo as the goal, silently count the number of times the photo appeared, two sets of experiments using the same five photos, photos appear in a different order, when the number of subjects and the real results are given photos a difference of 5 or less, are considered experimental data effective;

(3) The experimental background includes three subjects familiar homosexual, a gay subjects are not familiar stranger: for face recognition research results show that the observer unfamiliar faces always cause different reactions in this experimental model to compare unfamiliar people affected in the experiment, the experiment with five photos, add a subject unfamiliar photo as background, after joining the stranger, the experiment will be what kind of impact, the same experiment was divided into two groups, first of all subjects to their own photo as the goal, and silently count the number of times their photos appear in the course of the experiment; and other subjects after the break for a second set of experiments subjects, subjects with strangers photo as the goal, and silently count the the number of photos appeared, two sets of experiments using the same five photos, photos appear in a different order, when the number of subjects and the real results are given photos a difference of 5 or less, are considered valid experimental data;

EEG acquisition is the use of 40 lead Neuroscan amplifiers, through scan4.3 software for acquiring, using the right of way of the mastoid reference electrode as the reference electrode, using 1000Hz sampling rate, the band collected using 200Hz low pass, 0.05Hz 50Hz high-pass and notch.

Two data analysis process

1, remove the larger drift EEG: The EEG acquisition process, because subjects such as sports, desertion, outside sounds and other effects, the initial EEG will be a big shift, will follow EEG treatment impact, therefore before EEG processing, to remove this part of the EEG signal;

2, go EOG: The original EEG because blink or look around, producing EOG impact on EEG, thus making the feature extraction and classification prior to the removal of this part of the impact of this paper is to remove the vertical eye electric impact;

3, segmented view stimulus interval, and generally 10% -20%, the common value is -50, -100; principle of no more than the beginning of the next event, the paper intercepted data segment in -100 ~ 923ms.

4, baseline correction: Because many of the data processing segment is not the baseline, this paper conducted two baseline correction and a linear correction.

5, the removal of artifacts: After the collected EEG classification, there are some segments of data is not good due to various reasons, not only for data analysis useless, but will affect the analysis of the data, so to select a certain window screening, we use the window is -80 to 80.

6, superimposed: This article is mainly on ERP EEG analysis, so the same type of brain electrical signals to stimulate the overlay process.

### 3 Results

This paper analyzes the subjects concerned with their own pictures and photos about the person's brain waves erp ingredient difference is about the person familiar with the boys from the group photos were familiar with the girls group and strangers. Figure 1 shows the concern and attention of others their own brain waves comparison chart (attention of others in this article refers to a group of subjects, specify a photo) for subjects under FZ electrode. Through a comprehensive look at the subject of EEG, EEG subjects more prominent ingredient (mainly refers to the peak valley) occurs in less than 400 milliseconds.

As shown in Figure 1 by the methods described above for the data analysis, the brain wave signal characteristics collected at different electrodes, can be seen, in the forehead region of the electrode, such as to have a more significant difference after FP1, FP2 300ms area of electrode, in the left and right brain area, 300ms before the more obvious features.

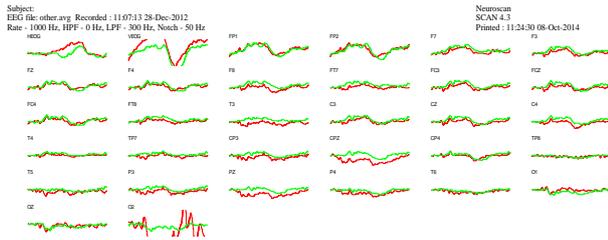


FIGURE 1 Pay attention to their own and others comparison general chart

ERP components include classical P1, N1, P2, N2 and P3, where P1, N1 and P2 belong exogenous (physiological) component, and the physical properties of stimuli associated with a certain, N2 and P3 are within the endogenous (psychological) component, the physical characteristics of objects from stimulus impact, but by the subject's mental state and attention influence. While being widely studied ERP components as well as N4, MMN and CNV and so on.

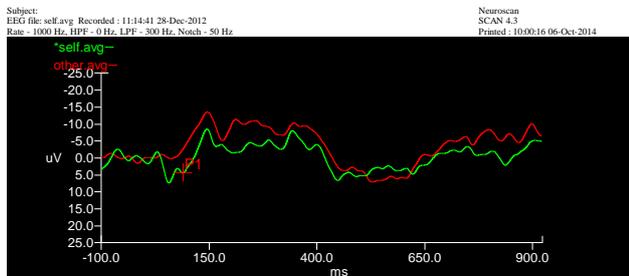


FIGURE 2 Pay attention to their own and others comparison chart of model 1

Figure 2 shows the subjects in mode 1, and concerns that the subjects concerned about their sex photos EEG a familiar ingredient comparison chart can be seen from the figure P1, N1, P2 and N2 components of the more obvious, the EUT for those concerned about their own time, with a clear P3 component appears, but about the person when the P3 component is not obvious.

For the P1 component, participants focus on themselves and others concerned about the main difference is that: the subjects concerned P1 component of others first to concern himself appeared, such as the case shown in Figure 1, the subjects about the person P1 appears in 84ms, subjects P1 were concerned about their constituents appear in 92ms.

For the N1 component, participants focus on the main differences between themselves and others that concern: the subjects concerned N1 component amplitude others concerned about their subjects than the amplitude of the case shown in Figure 1 subjects focus on others sites value of -4.148 microvolts, concerned about their amplitude is -3.418 microvolts; Meanwhile, the subjects concerned N1 component of others first to concern himself appeared, such as the case shown in Figure 1, the subjects about the person appeared in N1 112ms, the subjects concerned about their N1 component appears in 117ms.

For the P2 component, participants focus on others and focus on their main difference is: the subjects concerned about their subjects concerned P2 amplitude than the amplitude of others, the case shown in Figure 1, the subjects concerned about their the P2 component amplitude of 5.939 microvolts, subjects about the person amplitude of 4.583 microvolts.

For the N2 component, participants focus on the main differences between themselves and others that concern: the subjects concerned about their subjects N2 amplitude than the amplitude of concern to others, for example in the case shown in Figure 1, the subjects concerned about their the N2 amplitude is -4.120 microvolts, while others focus on the magnitude of -0.304 subjects microvolts; subjects focus first on the N2 component of others concerned about their subjects appear, the case shown in Figure 1, the test others were concerned about the N2 component appears in 197ms, the subjects concerned about their N2 component appears in 208ms.

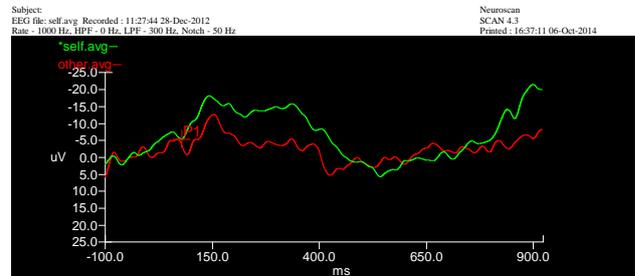


FIGURE 3 Pay attention to their own and others comparison chart of model 2

Figure 3 is the subjects and the subjects concerned about their EEG component concerned at the comparison chart opposite case, the following, as for P1, N1, P2, N2 P3 component of the difference and described in detail.

For the P1 component, as shown in case 2, P1 component when the subjects concerned about their situation than under the attention of others appeared later, as shown in Figure 2, the subjects concerned under their own circumstances P1 component appears in 63ms, while others focus ingredients appear in the case of P1 74ms;

For the N1 component, as shown in two cases, the subjects were compared attention and concern of others under their own conditions, subjects concerned N1 component occurs under circumstances than others concerned subjects appear under their own conditions early, as two show cases, the subjects concerned under their own circumstances N1 component appears in 111ms, the subjects concerned under another case N1 component appears in 105ms;

For P2 components, subjects attention and concern of others under their own circumstances reflected in the amplitude of the main difference to the case shown in Figure 2 as an example, the subjects concerned under their own circumstances P2 amplitude of 2.734 microvolts, subjects about the person case under the amplitude of 5.591 microvolts, obviously concerned

about the subjects under circumstances P2 magnitude larger than others concerned about their magnitude;

For the N2 component, subjects concerned under their own circumstances and concerns of others mainly reflected the difference in magnitude to the case shown in Figure 2 as an example, the subjects concerned under their own circumstances P2 amplitude -2.629 microvolts, participants focus on others case amplitude -3.015 microvolts, obviously concerned about the subjects under circumstances P2 amplitude than others concerned about their large amplitude;

For the P3 component, subjects participating in the experiment under the heterosexual model, attention and concern themselves heterosexual have shown a significant P3 component, the main difference is reflected in the emergence of the time, the subjects concerned P3 component own case, as two illustrated stories, appeared in 287ms, while others happen next subjects concerned in 265ms.

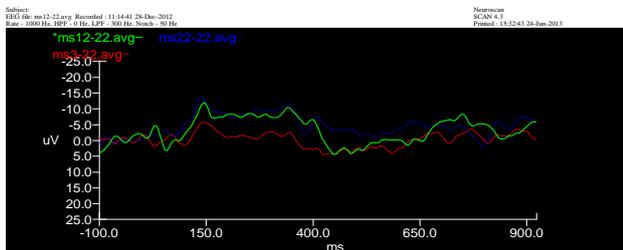


FIGURE 4 Pay attention to their own and others comparison chart of model 3

Figure 4 shows the composition of the subjects concerned EEG comparison chart and concern themselves strangers (homosexual) mode, P1, N1, P2, N2 and P3 components of the difference in this mode is as follows:

P1 component, subjects participating in the experiment in the case of a stranger, pay attention to their constituents appear P1 is not obvious, the case shown in Figure 3, there have been brief in 100ms P1 component and is not obvious, but for strangers concern, P1 component is more obvious, as shown in Figure 3 cases appear in 91ms at;

N1 components, subjects participating in the experiment in the case where strangers, N1 component is more obvious, the main difference between the subject N1 component concerned about the person himself and in that case the amplitude component N1 shown in Figure 3, the test were concerned about the magnitude of -3.768 under their own circumstances microvolts, subjects concerned under others, the amplitude of -1.687, significantly lower than the magnitude of attention to their own situation;

P2 components, subjects attention and concern of others under their own circumstances reflected in the amplitude of the main difference to the case shown in Figure 3, for example, focus on subjects under their own circumstances P2 amplitude of 2.790 microvolts, subjects another person under circumstances concern amplitude of 5.384 microvolts, obviously concerned about the subjects

under circumstances P2 magnitude larger than others concerned about their magnitude;

For the N2 component, subjects attention and concern of others under their own circumstances difference mainly reflected in the emergence of time in the case shown in Figure 3, for example, focus on subjects under their own circumstances N2 appears in 217ms, the subjects concerned under the circumstances of others appeared in 240ms;

For the P3 component, the subjects attention and concern of others under their own circumstances difference mainly reflected in the emergence of time in the case shown in Figure 3, for example, focus on subjects under their own circumstances P3 appears in 250ms, the subjects concerned under the circumstances of others appeared in 270ms;

#### 4 Conclusions

In same-sex and are familiar with the subject mode analysis and comparison of the results of the tubes themselves and focus on others subjects, the purpose is to study the concern and attention to their same-sex companions difference ERP components

There are different EEG components, corresponding to different subjects mental state and the extent of the impact of different stimuli on the subject.

In three different experimental models, from the five component analysis, although participants are concerned about their own and others concerned about the EEG were compared, but the results are not the same:

In the three modes, P1 ingredients appear in time, others are concerned about the situation earlier than concerned about their own situation, which indicates the degree of response of the photo subjects concerned about others than concerned about the situation under their own feedback more quickly, Because of their photos more familiar, and therefore require more information to feedback, so P1 component of subjects earlier than others concerned about their concerns;

For the N1 component, whether homosexual or heterosexual background, the component amplitude is always higher than concerned about their situation, this paper, this phenomenon is mainly attributed to a person familiar with the novel reflects, as novelty, but also because of concern, so there higher amplitude, but for strangers, though novel, but do not care, so there are no higher than N1 component concerns itself;

The same situation occurs in the amplitude of N2, the P2 component, for already more advanced components N2, P2, to some extent, there have been processing information with a certain psychological state of the people for the stranger and for the opposite sex in early psychological processing does not appear on instinct, although more indifference, but the latter part of the mental process, the reaction is more intense, so the magnitude of the subjects and strangers of the opposite sex for the next case, by a big margin.

Different experimental models, from the point of view of EEG analysis of different ingredients, reaction subjects vary, but in general there is a certain regularity, through different, summed up the law on the photo reaction can reflect subjects the extent of reaction for a particular photo.

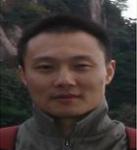
## References

- [1] Palaniappan R and Mandic D P. EEG Based Biometric Framework for Automatic Identity Verification. 2007 *The Journal of VLSI Signal Processing*, 49(2): 243-250.
- [2] Palaniappan R. Method of identifying individuals using VEP signals and neural network. 2004 *IEEE Proceedings - Science, Measurement and Technology*, 151(1): 16-20.
- [3] Palaniappan R. Electroencephalogram signals from imagined activities: a novel biometric identifier for a small population. 2006 *Lecture Notes in Computer Science*, 42: 604-611.
- [4] Touyama H and Hirose M. Non-target photo images in oddball paradigm improve EEG-based personal identification rates. 2008 *Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 1:4118-21.
- [5] Wardzinski R. Emerging biometrics: EEG-based identity verification. *Proceedings of SPIE, the International Society for Optical Engineering, Photonics applications in astronomy, communications, industry, and high-energy physics experiments*, 2006, 6347(2).
- [6] Poulos M, Rangoussi M and Kafetzopoulos E, Person identification via the EEG using computational geometry algorithms. 1998,

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- Proceedings of the 9th European Signal Processing (EUSIPCO '98)*, 2125-28.
- [7] Poulos M, Rangoussi M and Chrissikopoulos V. Parametric person identification from EEG using computational geometry. 1999, *Proceedings of the 6th International Conference on Electronics, Circuits and Systems (ICECS '99)*, 2: 1005-08.
- [8] Poulos M, Rangoussi M, Alexandris N, et al. On the use of EEG features towards person identification via neural networks. 2001 *Medical Informatics & the Internet in Medicine*, , 26(1): 35-48.
- [9] Pins D. The neural correlates of conscious vision. 2003, *Cerebral Cortex*, 13(5): 461-474.
- [10] Wilenius M E and Revonsuo A T. Timing of the earliest ERP correlate of visual awareness. 2007 *Psychophysiology*, 44(5): 703-710.
- [11] Koivisto M, Kainulainen P and Revonsuo A. The relationship between awareness and attention: evidence from ERP responses. 2009 *Neuropsychologia*, 47(13): 2891-99.
- [12] Koivisto M and Revonsuo A. The role of selective attention in visual awareness of stimulus features: Electrophysiological studies. 2008 *Cognitive, Affective, & Behavioral Neuroscience* 8(2) 195-210

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