



# Cognition, Emotion and Brain Mechanism: Neural Mechanism of Animation Cognition Based on Gender Difference

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## ABSTRACT

At present, since the era of development of cognitive neuroscience has begun, the researcher has started to explore the relationship between the cognitive development of animation, and the influence on the brain structure and features by MRI and other brain imaging techniques, so as to reveal the relationship among physiology, perception and emotion. Teenagers with different genders have different patterns of cognitive activity, and consequently the brain structure and the characteristics of its activity with gender differences when watching a cartoon have provided a significant inspiration. Based on the results of gender difference, age difference, data of ERP and traceability, the investigation of the article has begun with the contrast of semantic information represented by the animation with the information of cognition degree of “animation-picture”. It has come to conclusions as follows: 1) In the semantic exchange of an animation, the perception and judgement of the emotional relationship are more difficult than those of the context; 2) People with different genders have obvious cognitive differences, and hence the film editing, the field of shooting scale and the movement of camera will stimulate the visual areas in the brains of male and female with quite different active degrees. And also, the audiovisuals of a film might have a stimulating synergy to the brains of male and female; 3) In the transition of “animation-picture-semantics”, both of P300 and N400 will emerge, which explains that the judgement of the above two relations is realized through the spatial memory and the understanding of meanings; 4) On the basis of the mutuality and interaction between the emotion and the perception, the analysis tracking down the source has discovered that, the functional area of semantic comprehension is mainly located at the angular gyrus of inferior parietal lobule, that is, Area 39 and the back of gyrus frontalis inferior (Area 44 and 45), which are included within the scope of visual and motor speech areas.

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## Introduction

With the development of cognitive neuroscience, researchers have begun to explore the basic problems of cognitive development, the neural mechanisms of developmental changes, the diagnosis and treatment of developmental disorders, and the relation between brain development and cognitive behavioral development with the aid of advanced brain imaging techniques. Since Casey *et al.*, (1995)

firstly used fMRI technology to study the difference of brain activity patterns in working memory between children and adults, there has been an upsurge of researches on the development of cognitive ability and brain development in children and adolescents abroad. For example, the National Institutes of Health in the US has been tracking hundreds of children and adolescents aged 6 to 18 across the United States since 2001, measuring their basic cognitive abilities such as intelligence,

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processing speed, and working memory every two years, and conducting magnetic resonance scans of the brain, in order to explore that relation between the development of cognitive ability and brain development. In addition, research institutes such as the Imaging Research Center in Cincinnati, Ohio, and the Sackler Institute for Developmental Psychobiology at Cornell University have also begun to explore the relation between cognitive development and brain development in children and adolescents. The exploration of these problems is of great significance to reveal the neural development mechanism of cognitive abilities such as sensory information processing, language comprehension, executive function control, learning, memory, reasoning and decision-making, and the relation between brain development and cognitive behavior development. Animation understanding is a process of information processing based on the cognition of words.

From the linguistic point of view, animation is the most basic speech unit with certain grammatical characteristics, which can express the complete thought. At the same time, the understanding of animation is also an inherent cognitive process, during which, readers of different gender accept the information transmitted by animation, and use it to construct an explanation and then build meaning through animation. Foreign researches on animation understanding and processing are very early, and many influential theoretical hypotheses and models are put forward, such as module theory and circle diameter model (May *et al.*, 2014; May *et al.*, 2016). In 1959, Wason firstly adopted the most popular "animation-picture" validation paradigm to study the process of animation comprehension. The method considers that the negative concept is more difficult to understand than the positive one (Horton *et al.*, 2014; Parajuli *et al.*, 2014). Kintsh also believes that this paradigm is the main and effective way to study human semantic memory (Donald *et al.*, 2016; Howells *et al.*, 2016). Since then, most researchers have adopted the "animation-picture" validation paradigm to study the processing of different animations in language comprehension. Clark *et al.* believed that the previous theories on "animation-picture" comparative processing are faithfully and specifically explaining how people represent, contrast and process animation and picture (Barnett *et al.*, 2009; Rattner *et al.*, 2007). So they put forward the "animation - picture" four

- stage model based on the previous researches, trying to explain the individual representation.

(1) Psychological representation stage of animation: When a given animation is presented, the subjects construct specific mental representations at different speeds according to the surface structure and store them in their brains in a propositional form.

(2) Psychological representation stage of pictures: In the same way, the individual represents the content of pictures and completes the psychological representation of the second stage.

(3) Comparing and processing stage of animation and picture representation: Animation and pictures are compared, the semantics of the two are identical, then a "true" judgment is produced, and vice versa, a "false" judgment is produced.

(4) Response stage: The subjects make behavioral responses according to the final cognitive judgment.

China started related researches since 1990 and Chen Yongming *et al.*, (1990) adopted the "animation-picture" validation paradigm to investigate the differences in time and correct rate of affirmative, negative and double negative sentences in understanding and verifying and their effects. In terms of response time, true affirmative sentence (TA for short) is shorter than false affirmative sentence (FA for short), which is shorter than false negative sentence (FN for short) , which is shorter than true negative sentence (TN for short) (Ye *et al.*, 2012). Xu Huohui (1990) studied the development of the comprehension of negative sentences and double negative sentences by children aged 4-13 years. It is found that 5-year-old children can understand the basic double negative sentences. The correct rate increases with the increase in age and decreases with the increase in syntactic complexity. He also believed that there may be some dominant mechanisms in children's understanding of the two animations, such as positive assimilation mechanism and sentence-end dominance mechanism (Funder, 2014). Miao Xiaochun *et al.*, (1992) found that the time of understanding animation meaning mainly depends on the relation between the surface structure and the deep meaning of animation; the time of validating a picture is influenced by the relation between the deep meaning of the animation and the proposition derived from the picture (Atran, 2014). In 1997, Wo (1997) used



the method of subtraction response time to investigate the internal psychological processing of college students' animation - picture. The experiment shows that in affirmative response, the "above" sentence is faster than the "below" sentence, and the "not above" sentence is slower than the "not below" sentence. In the negative response, the "above" sentence is slower than the "below" sentence.

The above research is mainly accomplished by collecting the behavior data of the subjects. On the basis of previous theoretical methods and research achievements, this paper uses the research method of combining behavior data, ERP data and traceable location, and compares the influence of positive and negative information and location information on animation understanding speed to analyze the activity of the brain in the process of understanding animation.

### Concepts and Theoretical Overview

#### EEG signals

Electroencephalograph (EEG) is a global reflection of the electrophysiological activity of the brain on the cerebral cortex or the surface of scalp. Clinical practice shows that EEG contains a large number of physiological and disease information, through EEG, not only providing doctors with the basis for clinical diagnosis but also offering effective treatment for some brain diseases (such as epilepsy, brain tumors and mental state treatment). EEG is a global reflection of the electrophysiological activity of the brain on the cerebral cortex or the surface of scalp. EEG research has been a very difficult and attractive task in the biomedical field.

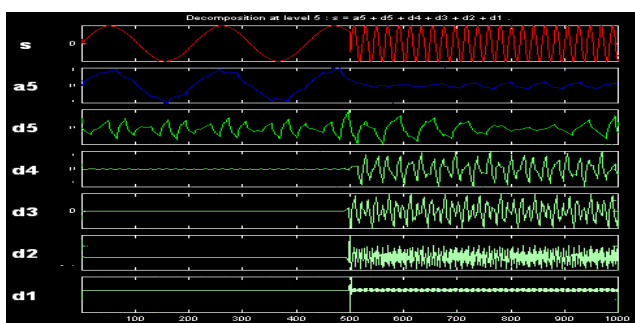


Figure 1. Common Db2 EEG signal decomposition

#### Animation recognition

With the development of film technology, animation technology emphasizing audio-visual feeling has entered into a developing period.

Along with the development of computer technology, the computer is used to create two-dimensional to three-dimensional animation, and animation technology develops into the mature period. When continuously and rapidly viewing a series of associated images for a certain period of time, the naked eye will feel a continuous moving image, thus forming an animation. Any animation should represent motion or change, but at least two different key states should be given before and after. In a flash, the frame representing the key state is called a key frame, which is generally displayed as a black dot. Two-dimensional animation is a kind of planar animation, reflecting only the animation technology of the upper-lower and left-right motion dimensions. Compared to two-dimensional animation, three-dimensional animation, also known as 3D animation, can not only reflect the movement of the upper-lower and left-right dimensions, but also can reflect the movement of the front-back dimension. The scene in the three-dimensional picture has not only the front, but also the side and back.

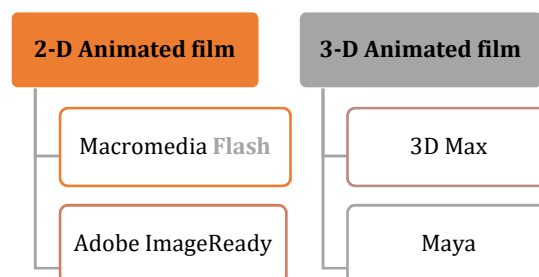


Figure 2. Animated film for 2D and 3D

The first module of the animation is generated automatically. Its main task is to analyze and understand the input of natural language text and to get a formal description of the story. All the nouns of any language system are represented by a symbolic line pattern that matches their meaning, and all their verbs are represented by a cartoon that is consistent with the meaning of the motion represented by their meaning. Then, the graphics corresponding to the nouns in one of the natural sentences and the cartoons representing the actions corresponding to the verbs are broken, and the sequence of the semantics formed by the natural sentences is linked to form an intuitively The animation that expresses the sentence meaning of this natural sentence is broken, and then combining these fragments can generate the desired animation.



**(1) Understanding the layer**

This layer uses natural language as input, and after a natural language processing technique such as lexical analysis, grammar analysis, and semantic analysis, it is converted into a formal description of FDI; and through the processing of the story understanding module, FDZ is formed as the output of this layer. This layer includes two modules for understanding natural language and story content, as well as corresponding dictionaries and syntax libraries.

**(2) Planning layer**

This layer describes FD according to the formalization of the story and conducts various planning on characters, plots, and scenarios of the story, including plot planning, role planning, scene planning, action planning, camera planning, and corresponding knowledge bases. At the same time it involves many algorithms, such as path planning algorithm, collision detection algorithm, camera algorithm and so on. The output of this layer is a standard XML document that contains almost all the information needed to generate an animation.

**(3) Conversion layer**

This layer uses a scripting language conversion algorithm to interpret and convert the planning layer XML document into a scripting animation language. When using different modeling platforms, different scripting language conversion methods can be designed to obtain corresponding script files. Since XML is a standard document, and all the information needed to generate an animation is almost contained in an XML document, this workaround is very easy and safe.

**(4) Presentation layer**

The script obtained by the conversion layer ultimately needs to generate the corresponding animation on the relevant modeling platform. For example, the Maya software invokes the MEL script output by the conversion layer and eventually generates an animation.

serious physical and mental history is recorded. The percentage of brain electrodes that are most closely related to each common factor is counted. Since the contribution rate of the first common factor is the largest, the proportion of the most closely related brain electrode in the first common factor is the most persuasive, and the proportion of the most closely related brain electrode in the first common factor is counted. The figure in Table 1 is the percentage of the most closely related brain electrode in the first common factor under the three states among the 15 subjects.

**Table 1.** Three states under the first common factor most closely related to the percentage of brain electrodes

Electrode	Relax before animation	Watch the animation	Relax after animation
FP1			
FP2			
F3	13%	40%	13%
F4	33%	7%	40%
F7		26%	
F8	13%	7%	7%
C3			
C4	20%		20%
P3		13%	
P4	13%		
O1			
O2	7%	7%	
T3			13%
T4			
T5			7%
T6			

**Experimental materials**

The experimental materials are 3 pictures and different types of animation related to the pictures. The three animations are an old man in the house, a plane above the car, and a five-pointed star to the left of a triangle. Among them, an old man in the house is for practice, the formal experiment materials are divided into two types of up-down relation (UD) and left-right relation (RL). Four sentence patterns: true affirmative sentence (TA), true negative sentence (TN), false positive sentence (FA), and false negative sentence (FN).

**Experimental process**

(1) Practice procedure: Before the formal experiment, choose the picture (an old man in the house) that have nothing to do with the experiment for practice.

(2) Formal experiment: Select "Given picture material" in the "Formal experiment" window, the subjects read the guidance carefully.

**The Experimental program**

**Subjects**

Subjects are 17 students (7 male and 10 female) in general colleges and universities. The subjects' native language is Chinese, and the animation is domestic. The average age of the subjects is about 20 years old, all of them are right-handed, and their vision or corrected vision is above 1. No



(3) Respond properly to the animation and pictures presented in accordance with the requirements of the experimental guidance. Fill in the information after the experiment.

(4) When finishing the experiment with one kind of experiment material, exchange other experiment material to continue the experiment. In order to avoid the influence of presentation order of different experimental materials on the experimental results, the order of Latin square design is adopted for the picture materials of the two formal experiments.

### Data processing

The ESI-64 EEG recording system produced by Neuroscan Company is used to record the EEG signal with Ag/AgCl electrode cap. The electrode position is set according to the international standard 10-20. Two electrodes in the upper and lower part of left orbit record vertical eye EEG, and two electrodes in the lateral side of both eyes record horizontal eye EEG. The reference electrode is located at the mastoid process. The right electrode is used as the reference during recording, and the double-side electrode is used as the reference during data processing. The ground point is midway between FPz and Fz. The acquisition gain of EEG is 500, the sampling frequency of A/D is 500 Hz, and the band pass of filter is 0.05-100Hz. The scalp impedance is less than 5K Omega. The time of analysis is -100-1000ms, the EEG of 100ms before stimulation is taken as baseline, the artifacts such as eye movement are automatically eliminated, the amplitude outside  $\pm 75\mu\text{V}$  interval is eliminated before superposition, and the band pass of the filter is 0.05-40Hz. The midline electrodes FPz, Fz, Cz, Pz and Oz of prefrontal, frontal, central, parietal and occipital regions are selected for analysis, and the analysis periods are determined as 200-600, 600-1000ms and 1000-1400 ms according to differential wave topographic map. For each period of time, repeated measurement of two factors memory judgment (2 levels)  $\times$  electrode position (5 levels: prefrontal, frontal, central, parietal and occipital) is performed for analysis of variance. SPSS12.0 software package is used for analysis of variance, together with Greenhouse-Geisser epsilon correction method.

### Parameter setting

Through behavioral data analysis and ERP data analysis, specific parameters include:

(1) Average response time: The total response time of a single subject/the number of responses;

(2) Response accuracy rate: Number of true response times/number of response times\*100;

(3) P300: It is a positive phase peak that occurs around 300ms. This component was first obtained by Sutton *et al* in the Oddball experiment. This component is mainly produced by stimulating memory regions in the human brain by means of attention, probability and target;

(4) N400: It is the peak of the negative phase that occurs around 400ms. This component was first obtained by Kutas *et al* in the experiment of ambiguity. The appearance of N400 is mainly induced by the sudden appearance of an ambiguous word in a sentence, which is often related to the meaning of animation.

### Behavioral data analysis

#### Behavior data of two types of relation

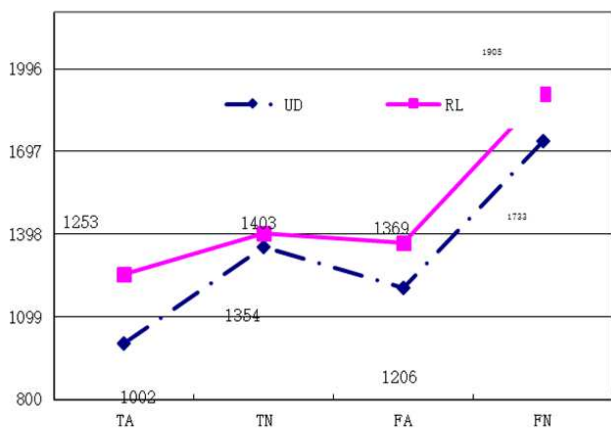
The behavioral data of the experiment include the true response time and accuracy of judging the target stimulus. In the experiment, 16 subjects have P (A) values of greater than 0.76, so the response of subjects is reliable. In order to eliminate the influence of extreme data on response time and accuracy, excluding the data with response time of longer than 2,500ms and shorter than 200ms, the average response time and the accuracy rate of two kinds of pictures and animation are obtained and the average understanding response time and accuracy rate of different sentence patterns are also obtained. From the table, it is concluded that the average response time of true affirmative sentence is the shortest and the accuracy rate of judgment is the highest, and the response time of judging the false negative sentence is the longest, and the accuracy rate is the lowest. True negative sentence and false affirmative sentence are listed in the 2<sup>nd</sup> and 3<sup>rd</sup> places. When testing the understanding of the left-right relation, the average response time of understanding different sentence patterns and the accuracy of the response is consistent with that of the upper-lower sentence.

#### Comparative analysis of response time and accuracy

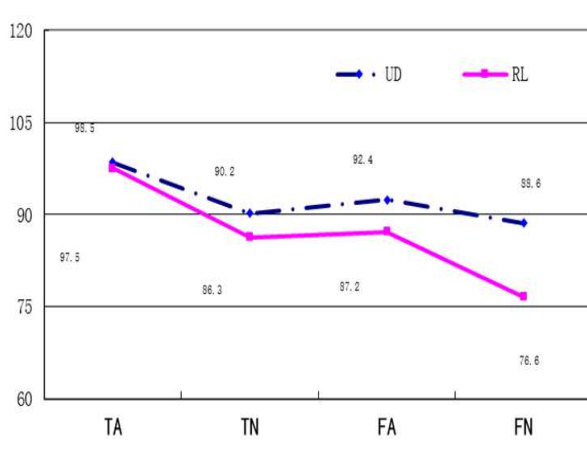
Response time, as an important parameter of human perception, mainly reflects the time required for understanding certain kinds of



things. Therefore, it is necessary to study the difference in time of understanding and verifying affirmative, negative and double negative sentences of upper-lower and left-right sentences and its influence. In Figure 3, the response time of the upper-lower relation is shorter than that of the left-right relation, which indicates that the response time required for judging the left-right relation is longer and more difficult. In terms of different sentence patterns, true affirmative sentence is less than true negative sentence, which is less than false positive sentence, which is less than false negative sentence.



**Figure 3.** The relationship between the different meaning of the reaction diagram



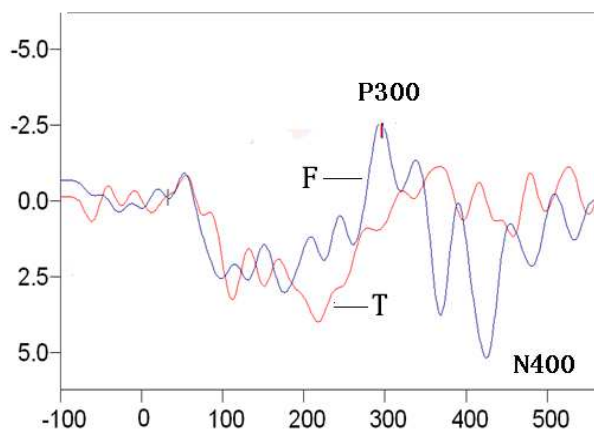
**Figure 4.** The relationship between the different significance of the accuracy of the reaction map

In Figure 4, the response accuracy of obtaining the upper-lower relation is higher than that of the left-right relation, which indicates that it is more difficult to judge the left-right relation. In terms of different sentence patterns, true affirmative sentences, which is greater than true

negative sentence, which is greater than false positive sentence, which is greater than false negative sentence. This is just contrary to the response time, which indicates that there is an inverse relation between the response time and the response accuracy in the process of language comprehension and judgment.

### ERPs data analysis

#### Upper-lower relation



**Figure 5.** Relationship between ERP signals

The results of ERP analysis of image and animation modes with the upper- lower relation show that the P300 components with amplitude peaks of -2.6uv and -1.3uv appear simultaneously in the two signals with opposite meaning (F) and consistent meaning (T), which shows that when human judge the meaning of the upper- lower relation, they rely on the memory of the location of the image. The peak of wave amplitude is 0.8uv and 4.9uvN400 near 400ms-450ms. This shows that in judging the upper- lower relation, there will be meaning judgment in addition to the function of space memory.

The amplitude of ERP signal is proportional to the difficulty of semantic judgment. The amplitude of P300 and N400 of F signal is greater than that of T signal. Therefore, it can be seen that in the context of the upper- lower relation, it's more difficult to judge when the image and animation meaning are opposite than consistent.

#### Left-right relation

Figure 6 is an ERP analysis of the image-animation mode with left-right relation. It is found that a peak of positive phase and negative phase also appears around 220ms-280ms and 380ms-400ms. This shows that both P300 and N400



appear when humans judge the meaning of left-right relation or upper-lower relation, and the judgment of such relation is realized through spatial memory and meaning understanding.

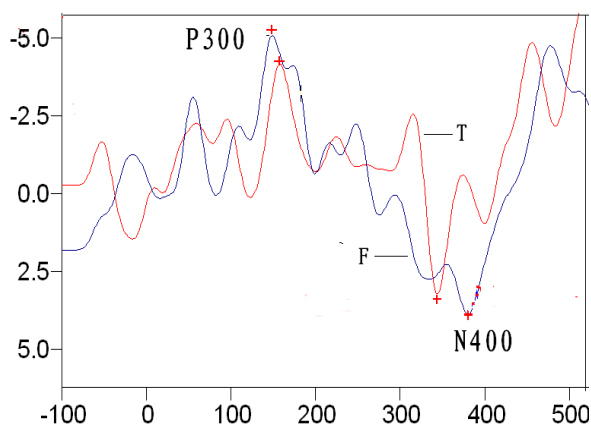


Figure 6. left and right relationship ERP signal diagram

### Conclusions

From the above studies on the development of cognitive skills and brain development in children and adolescents, it can be seen that although the development of cognitive neuroscience has a short period of time, researchers have explored the development of individual cognitive ability and brain development from multiple perspectives and levels. Relevant, and has achieved fruitful results, this is of great significance for enriching the traditional theory of developmental psychology and research findings, understanding the brain neural mechanisms of individual cognitive development, and providing advice for education, teaching, and clinical research. The advent of ERP technology has created a new era of neural electrophysiology. For more than half a century, ERP technology has been widely used in areas such as brain function research, psychology, cognitive neuroscience and clinical medicine. However, there are still few

studies on linguistic cognition related to it. In this paper, four different sentence patterns of upper, lower, left and right are judged by ERP experiment, and the cognitive process and brain The activity situation laid a foundation for further studying the brain mechanism of Chinese animation understanding.

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