



Revelations of the New Developments of Brain Science on Early Education

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Abstract

The development of information technology has drove the large revolution of brain science and made it go into the new development stage. The new development of brain science must deeply influence the education, especially for the early education, which makes our attention focus on how to develop children brain again. From the world developments of the research of “brain science and education”, in this article, we will research the revelations of the concepts such as “learning” and “education” in the domain of the cognitive neuroscience and the development of brain science on the early education.

Keywords: Brain science, Information technology, Early education, Neural circuit

1. Introduction

The competition among countries in 21st century is the competition of talent in the final analysis, and the cultivation of talent can not leave the education. Therefore, the good education is extremely important for national security and flourish. The education is also the important topic for discussion in the human society, and to cultivate good moral character, excellent intelligence and healthy physique is the material base to strengthen any one nation.

The continual development of information technology brings revolutions for the development of brain science and fluctuate the traditional concept of brain science and makes it obtain new scientific meanings. Taking the neurobiology as the center, the brain science is the science on the based of animal experiment and brain injury researches. In recent years, with the mature of brain imaging and scanning technology, this science has directly and safely observed super functions in the brain including human mental activities, which is the result that many subjects including molecular biology, medicine, psychology, neurobiology and engineer intercross each other and research together, and it makes the researches of brain science go into the new stage.

The new development of brain science deeply influences the domain of education, especially for the early education. Therefore, it is more and more necessary to research relative problems about early education from the view of brain science. The environment and education in the period of infant is very important to form one's personality and develop one's ability, and many research projects about how to develop infants' brain and how to implement more effective early education to children are more and more emphasized. So it is a very important topic to develop early education and do well infants' brain developments and even the future of the whole mankind.

In this article, we will discuss many aspects such as the background, feasibility and implementation methods of early education and infant brain development.

2. The world developments of the research of “brain science and education”

2.1 The research developments of OECD

In 1999, the CERI of OECD put forward the first research plan (1999-2001) of “learning science and brain science”. That research topics included “brain structure and infant learning”, “brain structure and youth learning” and “brain structure and aged learning”, which are convened international forum respectively in New York, Granada and Tokyo. The New York forum mainly discussed the brain plasticity and the child special sensitivity period, reported some problems about early education and brain science, such as language study, early cognitive ability, reading structure, mathematic thinking and feeling growth. There were two topics in Granada forum, one was to apply up to date results of cognitive neuroscience to the educational domain by the simple and pellucid form, and another one was to apply brain function imaging technology to find that the brain in the youth period (20-30 years old) was still in the growth. The topic center of Tokyo forum was to open out the brain essential in the aged period and how to enhance the cognitive enginery in the aged period.

In May of 2002, OECD begun the second plan (2002-2005) of “the application research of brain science in the domain of education”, some scientists in US, Europe and Japan had formed three research divisions and cooperative organization. US mainly researched the relationship between language and brain, Europe mainly researched the relationship between arithmetic and math with brain, and Japan mainly assumed the research about the combinations of brain and education such as lifelong learning and human observation ability, memory and “desire”. These researches had produce large influence in many countries and been changing the educational policy and educational practice of many countries.

In July of 2007, one up to date report issued by OECD showed that the brain would never lose its learning ability, not only the learning process could not be stopped, but the brain could be changed physiologically by learning. The emotion could rebuild human nerve organization, and one of the strongest learning motivations came from the understanding to the new concepts. The report also advised that the early education should obtain the experience of “elicitation” for children to ensure they could feel the happiness of learning. The report also called on the education science should cooperate with brain science to establish a new subject, i.e. the learning science, and finally made the education decision and education practice obtain stable scientific proofs.

2.2 The research developments in US

In 1990s, US defined the period from 1990 to the end of the 20th century as “ten years of brain”, and passed the topic to push the topic of brain science research, and the extensive researches about brain science, such as the pathogeny explanation and cure method of spirit disease. In virtue of this chance, various main universities in US established the special research institutions of brain neuroscience, and researches of brain science were continually coming forth, and when they took part in the mutual research of OECD, they developed their own independent researches.

The US National Institutes of Health (NIH) is pushing the research of brain science, and especially the National Institute of Biomedical Imaging and Bioengineering (NIBIB) established by NIH took the development of “Imaging technology” as the intention, and attracted attentions in the measurement technology of brain enginery. Otherwise, US National Science Foundation (NSF) and Finance Ministry also put forward the research project to develop and comprehensively improve human ability and technology in Dec of 2001, and they integrated multiple subject researches to promote the strategic development of brain science and education research project.

2.3 The research developments in Japan

After Japan instituted and implemented the “human proceeding science plan” which put the brain research on the important position in 1986, it also pushed the brain science plan program of “brain science times” with 20 years in 1996. Scientists predict that the brain science would occupy especially important status in 21st century. Based on that, fully considering the actuality and tendency of social development and combining with the cognitions of deficiencies about illegibility and experience existing in the research of education science, scientists should closely combine the brain science and education, and develop application research. In May of 1997, the Brain Science Committee of Life Science Branch in the Scientific Technology Meeting put forward the “long-term plan about the development of brain research”, and established the strategic objective of “understanding brain (the explanation of brain function)”, “protecting brain (the overcoming of brain disease)” and “creating brain (the development of brain computer)”. Japan established the brain science comprehensive research center of physical and chemical graduate school in Oct of the same year, which became the core institution of the research of brain science to implement the explanation of brain function. Above various researches have obtained many developments, and the non-invasive brain scanning and imaging technology has got quick development, which has developed the technology with more exact and safe, and applied the research results into the child education, school education, social life and aged nursing. Based on that, the evaluation branch of scientific technology and learning consideration research plan of Japanese Ministry of Education put forward the new strategic objective of brain science research, i.e. “brain cultivation”, in 2002.

Japanese Ministry of Education convened the meeting of “brain science and education” in March of 2002, and in this meeting, Japanese brain scientists definitely pointed out that the research combining brain science with education is an important tendency in the domain of education research in present Euro and American developed countries. After that, Japanese Ministry of Education convened meeting many times to further definite the research details, and formally started large research project of “brain science and education” on the new year’s day of 2003.

3. To explain the concepts of “learning” and “education” from the view of cognitive neuroscience

3.1 New explanations of learning and education

Owing to the traditional opinions, the “education” is the practical domain on the base of psychology, pedagogy, philosophy, sociology and cognitive science, and the “learning” is the process of repeat practices under the instruction from teacher. But as viewed from the view of the cognitive neuroscience, both learning and education are closely relative with the development of brain, because the brain is an information processor which can continually adapt the stimulus from the exterior environment.

The so-called “learning” is the process constructing the nerve centre circuit because of exterior environmental stimuli (except for oneself). The “education” is the process to control and complement exterior stimulus (H. Koizumi, 1999, p.5-24).

The learning is the process that the brain reacts to the environmental stimulations through establishing the nerve link, and this nerve link in the process is used in the information disposal circuit and the information memory. The education is to lead and inspire the construction of brain information disposal structure through offering, controlling and inputting stimulus for learners. The learning process includes many postnatal factors such as the formation of basic nerve link in the infant period, the formation of long term memory, and the reconstructions of some functional areas.

According to this concept, in the process of education, pedagogues should add effective stimulus to help learners construct corresponding nerve circuit and enhance their learning efficiencies. However, many problems such as how to discriminate “effective stimulations” to fulfill different learners’ demands, whether the “learning” from exterior stimulations breaches the “education” of exterior stimulus controlled and offered by the school and so on also need us to further study.

3.2 To treat the relationship between brain science and education from the dimension of “life-long education”

As viewed from systematic opinion, the “learning and education” can be treated as a whole concept from the fetus period, the infant period, the youth period, until to the aged period and death (seen in Figure 1).

As seen in Figure 1, the above “learning” and “education” are the lifetime concepts from birth to death. As viewed from the view of the research of “brain science and education”, the “learning and education” has been enlarged from the past narrow concept to the concept of “lifelong education”. Through experiments, we have found that human could learn from natural environment, cognize space through vision, take love through touch, be familiar with tone and rhythm through music, and understand phoneme and rules to produce expression through language from birth to death, which was induced by the feeler combination in the brain. So we can utilize language, music and natural environment to cure the group with obstacles. Otherwise, from the water environment in the fetus period to child education, elementary, middle and higher education, language education, obstacle child education, healing, occupational education, brain disease prevention, violence prevention, education economics, we can re-research these phenomena about learning and education from the view of biology. From the Figure 1, the infant period is the important period to construct the basic nerve circuits such as thinking and feeling.

In the infant period, even the fetus period, we should offer the environmental stimulus according with the growth of children possibly, which will influence the lifelong development for children. Most parts of this work are completed by the children’s parents, so to enhance the parents’ or quasi-parents’ qualities, means enhancing the quality of the whole nation, and further enhancing the strength of the country to some extents.

4. The revelations of the developments of brain science on early education

Generally speaking, the early education is the education from zero to six years old. In this period, many modes such as game can cultivate good abilities including language, painting, space, computation, music, sports, feeling and communication for children and the educational activities to promote their developments are called early education.

According to the up to date developments of world countries to the research of brain science and the new concept of “learning and education” put forward by Japanese brain scientist H. Koizumi, we thought that the early education should pay more attention to the infants’ potentials and implement education as early as possible according to the natural rule of child development, that is to say, offer them relative stimuli environment as early as possible to establish the nerve centre circuits according to their individualities, and grasp the “intellect dawn” occurred in the development process of infant and timely supply appropriate stimulus to fulfill their demands to the development.

4.1 Emphasizing the “potential ability” infants’ developments and instruct them early

Japanese early education expert Kimura thought that the children potential ability followed the rule of descending. Supposed that the child with 100 degree potential ability when he was born, and if since his born, we offer ideal education for him, so he may become an adult with 100 degree ability. If we teach him since he is 5 years old, even if the education is very excellent, he can only become the adult with 80 degree ability. And if we teach him since he is 10 years old, no matter how good the education is, he can only achieve the adult with 60 degree ability. In another words, the education begins later, the chance that the child can realize his ability is less. That is the famous child potential ability descending rule (Kimura. Kyuichi, 2005).

Some researches showed that though the inheritance is important, but in the growth process of every child, the early education also exerts large function and build the character from inheritance, and the influence of early education is much stronger than the inheritance. The early education exerts sustainable influences to one’s lifetime, and when the infant is just born, his brain is in the status of extreme vacuum and possesses hundreds of millions brain cells and nerve cells which are the physiological base for their lifelong thinking, communication and learning. However, these nerve cells are not linked to be nerve circuits with complex functions. Obviously, the stimulation exerts large function to form and develop the nerve circuit, and it also can change and adjust the nerve circuit system in the development. The learning starts from the initial several hours in life and with the advent of new stimulation, the brain of the infant form and strengthen millions nerve knots in nerve cells to construct the individual nerve centre circuit system.

The following experiment indicated the neonate possesses special sensitivity to the language. According to the result that researchers measured neonatal hearing, we can clearly see that the neonate has obvious reaction to the mother language. In the experiment, researchers used the “optical tester” to measure the neonate in Italy when they were born in five days (seen in Figure 2).

According to Figure 2, when the neonate hear the tape of mother language (Italian) conversation, because the red area represent the activity of brain cell in the brain, so we can think the reactions in the brain are very obvious, after that, when the tape is over and rewind, because the voice is not the language, we can see the red area in the brain becomes very weak, which means the reaction in the brain is very small, and when the tape stops, the red area basically disappears, which means there is not any reactions in the neonatal brain, and thus it can be seen the neonate possesses special sensitivity to the mother language.

We thought that immeasurable potential abilities exist in the children, and we should offer them appropriate environmental stimulus as early as possible, i.e. construct the corresponding nerve centre circuits in the children’s brain as soon as possible, and make their various potential exert, which is the premise to develop the early education.

4.2 Flowing the “intellect dawn” for infants’ developments and instruct them timely

The Germany famous educationist Karl Weter emphasized that the education to the children must begin with children’s “intellect dawn”. In the process of early education, the children are been found to possess “intellect dawns” in different stages, and if we can grasp these “intellect dawns” written in water and timely teach children, we will get twice the result with half the effort. The similar opinion is another concept of “critical period”. The Nobel Prize of medicine and physiology winners Hubel and Wiesel had put forward the concept of “critical period”, and they thought no matter what children do, when they miss the special period, they will be difficult to be cultivated in certain aspect, that means, there is a time limitation. The term is the important shed whether the children can grasp certain ability, and it is called as “critical period”. About the experiments of “critical period”, the example which was cited most is the vision experiment of a little cat. Put one just born cat in the environment that the walls in all sides are painted with transverse lines, after two weeks, when this cat enters into usual environment, the obstacles will appear in the vision of the cat, and the cat doesn’t know vertical lines, and it only know the transverse lines on the horizontal direction. That means two weeks since the cat is born is the “critical period” to obtain normal vision.

When we investigate the reason which induces the obstacle of cat vision, we find that the body of the cat is normal. The cat originally possesses the visual function, only in the growth period of cat vision, we don’t offer it appropriate environment, so the cat doesn’t establish its normal vision.

In the same way, in the growth process of children, there are many periods of “intellect dawn”, and when every “intellect dawn” comes, children will be very interested to certain one of special abilities such as painting, music and language and grasp it well. When the period is missed, to one child, he will be very difficult to grasp this sort of ability. Some researches indicated that children’s “intellect dawn” of language was before their 8 years old, and they investigated the relationship between age and present English ability to Chinese and Koreans when they migrated, and the result showed that the residents they migrated before they were 7 years old, they possesses same English ability with American, and when they exceeded 8 years old, their English learning abilities would toboggan, and once they exceeded 15 years old, their English learning abilities were not relative with the age of migration. That is to say, the plasticity of language intellect will achieve flood tide when children are in about 8 years old, and it toboggans when

children's ages exceed 15.

The unfortunate girl Gini of US also shows that in the "critical period" of language, if children can not obtain enough language stimulation, they will lose their abilities to obtain language. When Gini was 20 months old, she was locked in a dark room by her father, and she was forced to separate with her mother and brother of 6 years old, and in 12 years' underground living without any freedom, what Gini heard and felt were only father's abuses and maltreatments. When she was rescued in 12 years old, she could only said several simple words such as "stop" and "no". Through the research to Gini, experts knew that the development of language needed exterior stimulations, and when children are separated with language environment, they would lose the ability to grasp the language.

We thought whether "critical period" or "intellect dawn", all indicated children would come forth the learning tendency to certain ability in the appropriate period, we should timely grasp this sort of tendency and quickly offer corresponding environment to fulfill children's curiosity and learning desire, which is the process to strengthen children's corresponding nerve centre circuit in their brains, and that is the key to develop early education.

4.3 Offering the "right soil" for infants' developments and instruct them naturally

"Right soil" is the good environment to suit for children's developments. To offer excellent learning environment for children is the guarantee for the success of early education. The "Suzuki Method" put forward by Japan famous educationist Shinichi Suzuki also emphasized "human is the son of environment". Suzuki thought if parents could pay attention to children's instincts and offer them the ideal environment, so all children will obtain a series of very outstanding abilities, and this theory was the same with children all over the world, and there was no exception (S. Suzuki, 1981). He gave the examples that the children born in the tropic are sent to the cold area to grow up, they will also produce anti-cold abilities, and the children born in China are sent to US to grow up, the English will become into their mother language. That indicates many human abilities are cultivated by the environment, not naturally.

The basic concept of "Suzuki Method" is that the music is just like a sort of language, and to grasp one sort of language, we must begin learning it from childhood, the begin is earlier, we can grasp the language like mother language. The music leaning also follows same principle, only children have the ability to grasp certain one musical instrument a little, parents should let them to study. When we teach children, at the very start, we should not teach them music score or any music theories, because that breaches natural rule just as teaching lettering and language grammar to a normal child when he could not speak.

The "Suzuki Method" emphasized letting children listen music first and following the natural rule. Before children learn a new music, however the rhythm is simple, they must repeat to listen the record of this music. And the method of listening should be also natural, they don't need absorbedly sit there and listen facing the recorder, they only listen the music in the most relaxed estates such as dining, gambol, various rest and half rest estates before falling asleep. Though exerting a subtle influence on children to be familiar with the music unconsciously, teacher will let them play the music on the musical instrument under his instruction, far from looking at music book or learning music theory, and the whole process is so natural like children learn to speak when they hear something.

Suzuki had opined that "have you seen the child without physiological deficiency could not speak?", and the learning of language was so complex, but there were no failing examples, and other learning could not fail of course, and it is obvious that there were only failed educations or teachers, there were no failed students. Whether teachers or parents follow natural rule, and don't compel to create an appropriate learning environment for children is extremely important.

We thought in the implementation of early education, the soul of Suzuki Method should be extended, and parents and teachers should pay more attention to offer appropriate learning environment for children, and adopt the rule to teach children according to the nature, which is the guarantee to successfully develop early education.

5. Conclusions

Children possess infinite potentials, the premise to develop early education is to offer appropriate stimulus for children and construct corresponding nerve centre circuits in children's brains. The "critical period" or "intellect dawn" also indicate that children would come forth the learning tendency to certain ability in the appropriate period, we should timely grasp this sort of tendency and quickly offer corresponding environment to fulfill children's curiosity and learning desire, which is the process to strengthen children's corresponding nerve centre circuits in their brains, and that is the key to develop early education. In the process of early education, we should adopt the natural rules to teach children, which will certainly fully enhance the efficiency of early education, and offer guarantees to successfully develop early education.

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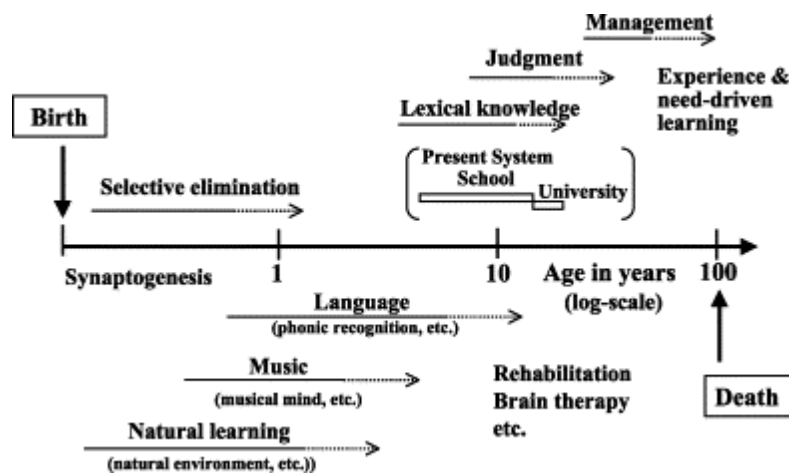


Figure 1. Life-long Learning and Education (A Natural Curriculum) (H. Koizumi, 2004)

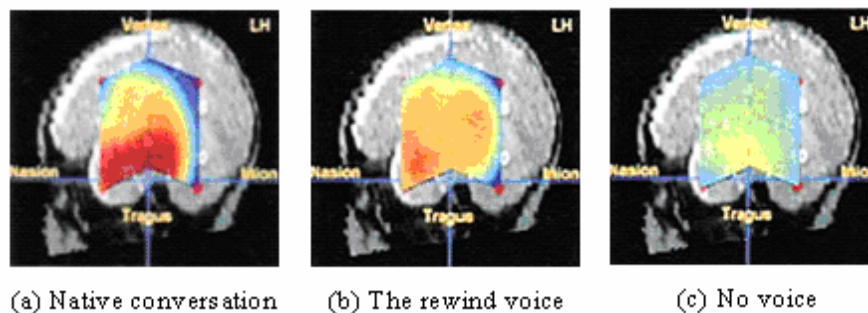


Figure 2. The Neonatal Brain Activity when Heard Native Language
(Neonate: In Five Days after Birth & Language: Italian) (J. Mehler's Group, 2003)