Brain Mechanism of Decision-making Behavior in Enterprise Employee Innovation Management

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ABSTRACT

With the advent of knowledge economy, the market has increasingly stricter demands on enterprises, which should have enough flexibility and innovation capacity in order to maintain competitiveness in the fierce market. The core competitiveness of an enterprise is talents. Employees, as the most valuable assets of the enterprise, can not only shorten the innovation cycle and respond quickly to the market, but also achieve the self-satisfaction and value realization if they can effectively exert their innovation ability. This study selects two groups of employees under different corporate cultures as experimental subjects, one enterprise has the perfect mechanism and system of all-involvement innovation, and the other has no ability of all-involvement innovation. The brain mechanism of employees' decision-making behavior in innovation management is studied by means of scientific research methods and advanced instruments. The results show that the brain structure of the employees with all-involvement innovation background is different from that of the employees without all-involvement innovation background in the right hemisphere, and the thickness of cortex and the volume of gray matter of the lateral occipital lobe of the right hemisphere are higher than those of the other group. Therefore, the long-term thought training and observation action have produced the plasticity change to the brain, which influences the nerve mechanism of the brain.

Key Words: Innovation Management, Decision Making Behaviour, Brain Mechanism

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Introduction

In the present age of knowledge economy, the chances of success of enterprises relying only on efficiency and effectiveness are greatly reduced, while in the present age of active creativity and rapid change (O'Sullivan, 2000), the most important way to maintain its own market competitiveness is to innovate and change (Lindsay, 1996), as we often mention, the only constant is change. The invention of technologies such as computers and machines can only help us to change and innovate (Amabile, 1988). The key factor in a true sense is talents, that's, employees of enterprises (Oldham and Cummings, 1996), who are the core of enterprise creativity and the most valuable asset of an enterprise. Nowadays, many enterprises have realized that bringing the innovation ability of employees into full play (Tierney and Farmer, 2004) plays an important role in shortening the innovation cycle and responding quickly to the change of market demand (Staw, 1990). On the other hand, the development of society and technology makes employees have higher requirements for the quality and content of work, while innovation in work can satisfy employees' needs for self-development and self-realization (Gong *et al.*, 2009) and keep enthusiasm and activity for work.

At present, the development of information management technologies also provides technical support for the management of employees' innovation, which makes the innovation efficiency of enterprise employees improve remarkably.

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With the development of cognitive psychology and brain science (Collins and Koechlin, 2012; Mender, 2017), researchers are paying more and more attention to the characteristics of enterprise employees' decision-making (Pennington and Hastie, 1991; Song, 2017) in innovative management situation. The enterprise employees search and the cognitive processing of these information in the innovation management situation (Zubair *et al.*, 2015), and then make the corresponding decision, which is an important link in the whole process. In today's changing times, if enterprises want to gain advantages in the market, the demand for innovation speed is also growing with each passing day. The level and speed of employees' innovation ability (Hasirci and Demirkan, 2007) directly affect the survival and development of enterprises. Therefore, the research on employees' innovative management decision-making behavior (Mabu *et al.*, 2013) is helpful to find out the factors that affect the accuracy of decision-making response and thus train and manage employees better. The development of brain science and brain imaging (Draganski *et al.*, 2006) provides the possibility and conditions for us to study the brain mechanism of this decision-making behavior.

From the references, there are few researches on the decision-making behavior of employees, except a few basic researches. The researches on the brain mechanism of employees' decision-making behavior in the innovative management environment (Lucchiari and Pravettoni, 2012) are more limited. Therefore, in order to deeply study the decision-making behavior of enterprise employees in the context of innovation management, the author studies and discusses the brain mechanism of decision-making behavior of enterprise employees in innovation management with scientific research methods and advanced instruments, so as to provide better ideas and basis for the innovation of enterprise employees (Sun *et al.*, 2017).

All-involvement innovation and decision making behaviors

All-involvement innovation

(1) Definition of all-involvement innovation

The term of innovation was first proposed by Austrian economists and then defined by scholars as "putting forth ideas and turning them into reality". The aim of innovation is to create new cognitive values. Innovation is not just the work and obligations of R & D personnel. Any employee in an enterprise can be an outstanding innovator. The idea of all-involvement innovation evolves from the "proposal system," and then was continuously promoted and improved in the world to form the present theory. The all-involvement innovation changes with the change of the times, but its essence is to encourage the employees to participate in the reform and innovation of the enterprise, transforming from the comprehensive quality management, continuous innovation, and the learning of the innovative organization to the all-involvement innovation. The thought forming process is shown in Figure (1).

The all-involvement innovation has many advantages: mobilize all staff's innovation ability to meet the market demand, thus shortening the innovation cycle; the enterprise employees of different positions know more about their own business, which contributes to the expansion of

Figure 1. All-Involvement Innovation Process

the scope of innovation field, let employees have a strong sense of participation, find pleasure and sense of achievement in innovation activities, and have the sense of ownership in enterprises.

(2) Main form of all-involvement innovation

All-Involvement innovation has been developed on the basis of the following theories: 1) Different people have different creative abilities; 2) In today's knowledge economy society, less professional knowledge but more cross-disciplinary experience and thinking is used in innovation, with tacit knowledge to propose and solve problems; 3) With the advent of the information age, the distribution of knowledge presents a decentralized state, and in the face of massive knowledge, people have limited knowledge; 4) The ecologicalization of innovation management. The above four points have laid a foundation for the emergence and development of all-involvement innovation in all aspects, and are also the driving force for enterprises to maintain prosperity and development. At present, enterprises mainly adopt the following forms of all-involvement innovation, as shown in Figure 2, and is also the management mode of enterprises for creativity.

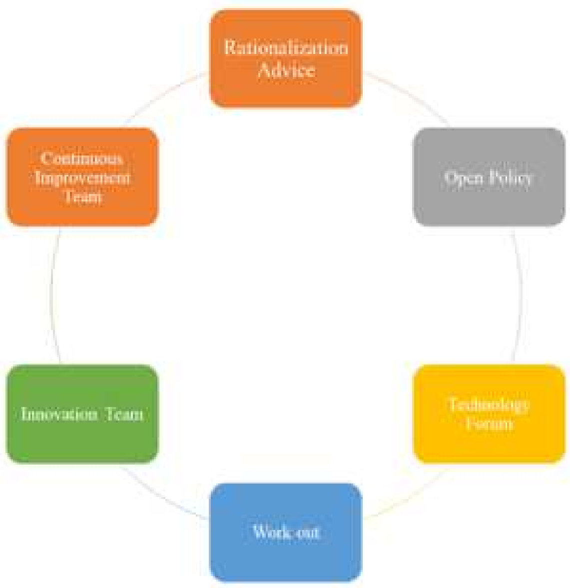

Figure 2. Main Form of All-Involvement Innovation

Decision making behavior

(1) Definition of dynamic decision making behavior

The study of decision-making behavior began in the 1940s, mainly based on decision-making and game theory, social psychology and other related disciplines. Scholars in cognitive psychology believe that the process of processing information is the process of decision-making, which is the process of analyzing and judging the most satisfactory plan in a scientific way among two or more plans for one purpose. In the process of innovation management of enterprise employees, there is a lot of information processing, judgment and decision-making. Judgment focuses on and evaluates the probability of occurrence of various events, while decision-making involves all the processes of making decisions, which are evaluated on the basis of the results.

In some cases, an innovative approach is proposed by processing the information that is not complete. The decision-making of an excellent employee in the process of innovation is often the use of feelings, experience or intuition to process and speculate on a limited amount of information, and use this information to make a reasonable decision within a limited period of time.

(2) Classification and research method of dynamic decision-making

Dynamic decision-making can be divided into intuitive decision-making and cognitive decision-making. Intuitive decision-making is a kind of advanced cognitive ability, which requires people to make decisions quickly and directly in complex situations. The cognitive decision-making is mainly carried out under the strict logic thinking, and usually the decision-making speed is slower.

At present, the research methods of dynamic decision-making mainly include recall method, recognition method, image freeze-up method, brain imaging method and psychological time measurement method. It's shown that the comprehensive application of these methods can effectively reveal the characteristics of decision-making process and the action mechanism of brain from the neural level and the action level.

(3) Study of brain nerve mechanism in decision making behavior

For hundreds of years, human beings have been persistent in the studies on the function and structure of the brain, and although they have mastered much of the knowledge of brain science, there are still many problems to be further studied and explored. The brain is divided into left and right hemispheres with similar structures, and its surface is covered with furrows of gyrus cerebral cortex and hundreds of millions of neurons. These structures and different brain regions realize people's complicated physical activities and thinking activities. The following Figure 3 illustrates the structure of the brain. Each hemisphere is divided into four major subdivisions of the frontal lobe, the parietal lobe, the temporal lobe and the occipital lobe.

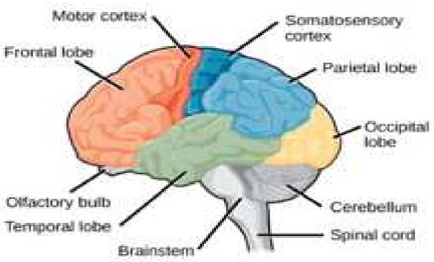

Figure 3. The Structure of the Brain

With the development of cognitive neuroscience and the breakthrough of brain imaging technology, the localization of brain function can be realized, and the activation area of brain can be determined by measuring the changes of blood flow and oxygen concentration. The activation region of the brain can be determined by measuring indices such as changes in blood flow and oxygen concentration.

Research method and experiment process

Research subjects

Among two enterprises of the same size, one of which has a perfect all-involvement innovation management mechanism and system, and the other has no background of all-involvement innovation, two groups of employees are selected respectively, one group are employees of A enterprise who can often put forward innovation suggestions or ideas and another group are employees of B enterprise who didn't propose innovative ideas at all, with 20 persons in each group, 10 males and 10 females, at the average age of 28 years old, and all are healthy, without history of mental illness, history of brain trauma, or drug dependence.

Research ideas

The brain accounts for a small percentage of the weight of the body, but controls all human behaviors and mental activities. Some studies show that the brain can alter its structure and function as it learns, experiences, and trains, which is a capability known as brain plasticity. The functions of different regions of the brain are not independent but closely related to each other, and the neural circuits of people who have been trained for long periods of time exhibit adaptive plasticity changes, but there are relatively few studies based on this. Therefore, the purpose of this study is to observe whether there is a difference in brain between enterprise employees with long-term continuous innovation and those without innovation experience, and whether the difference is related to long-term observation and thinking.

Experimental process

Magnetic resonance imaging (MRI) system is used to collect structural images of brain (figure 4). During the experiment, the subjects are asked to lie on their backs, with a sponge to fix the gap between the earphone and the coil in order to reduce the movement of the head. A standard high-resolution 3D image of the whole brain is obtained using sagittal sections. The scanning parameters are TR=2000ms, TE=2.05ms, thick layer=1mm, and resolution=0.5mm X 0.5mm X 1mm.

Figure 4. Magnetic Resonance Imaging Process

Data analysis

The images obtained by the magnetic resonance imaging system are subject to structural image data analysis and cortical thickness data analysis. The structural image data are analyzed by morphometry based on voxels, and the density of tissue components can be quantitatively analyzed. This experiment uses MATLAB to process and analyze the data, and finally obtains the image resolution of 1mmX1mmX1mm.

The cerebral cortex is reconstructed and segmented by the analysis software in structural image, so as to segment the hippocampus and amygdala, and then the rest of the cerebral cortex is standardized by grayscale. After the cortical model is built, the thickness of the cortex is measured by further data processing, and the cerebral cortexes with different thickness between the two groups are compared.

Results and discussion

Comparison of cerebral cortex thickness (figure 5)

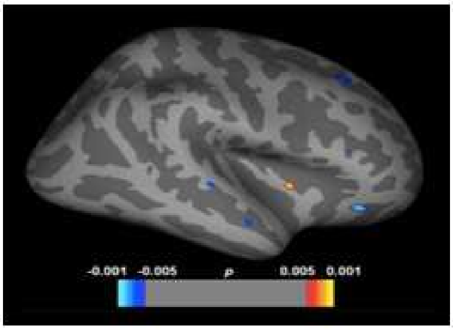

Figure 5. Whole Brain Cortical Thickness Comparison

The cerebral cortex is composed of a large number of neuron cells to process information of the brain. Its thickness refers to the thickness of the gray matter of the brain. This experiment compares the thick Brain Cortical ness of the cerebral cortex measured by magnetic resonance imaging between the two groups through software and corresponding correction methods. According to the results, the values of cortical thickness in the occipital region of the right hemisphere of the employees in the creative group are 2.36 mm and 2.24 mm, respectively, and there are statistical differences among the tissues. This means that the cortex contains a greater number of neuron cells, which are more active than in the ordinary group.

Comparison of the volume of gray matter in the brain

The following table shows the differences in the volume of gray matter in different brain regions of the right hemisphere between the two subject groups. It's shown that the volume of gray matter in the lateral occipital lobe and medial temporal gyrus is higher in the innovative group than in the ordinary group, while that in the anterior central gyrus and hippocampus is lower in the innovative group than in the ordinary group. When the voxel value is higher than 30, the difference between the lateral occipital lobe and the medial temporal gyrus is obvious. When the voxel value exceeds 50, only the upper part of the lateral occipital lobe is significantly different.

Figure (6) shows that the volume of gray matter in the areas of the fusiform gyrus and the central anterior gyrus is higher in the ordinary group than in the innovative group.

Figure (7) shows that the volume of gray matter in the upper occipital and lower temporal lobe regions of the ordinary group is lower than that of the innovative group.

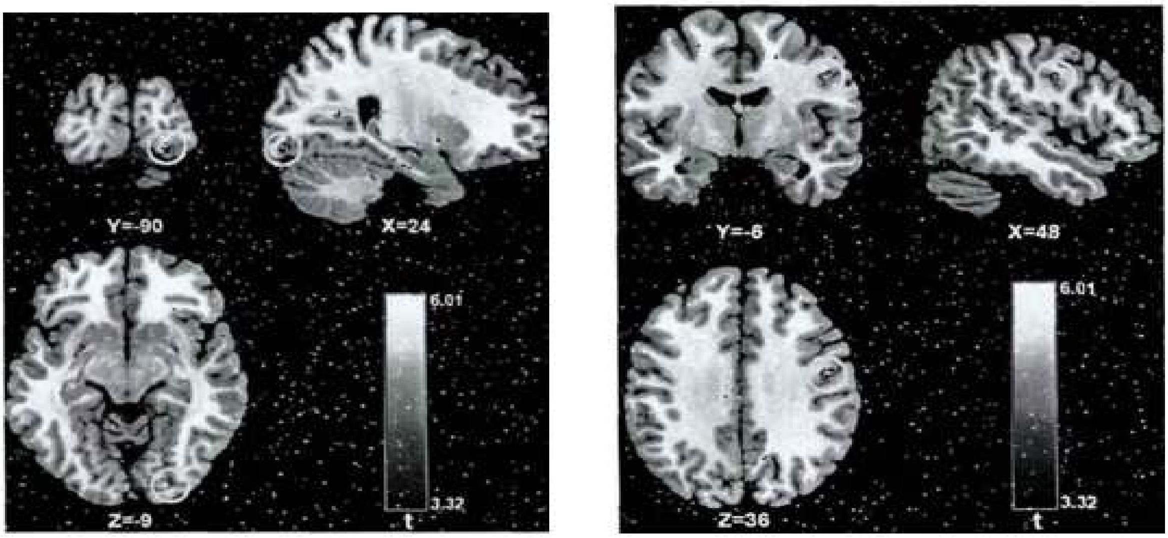

Figure 6. Dentate Gyrus Cortical Mass (Left) and Central Frontal Cortical Mass (Right)

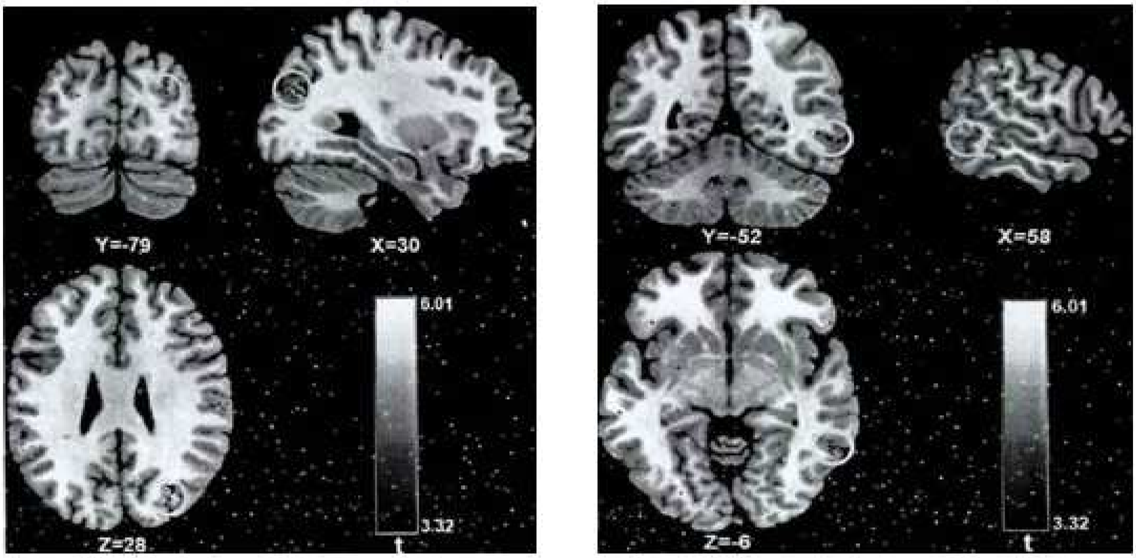

Figure 7. Upper Occipital Lobe Cortical Mass (Left) Lower Temporal Lobe Cortical Mass (Right)

Table 1. Brain Area Differences in Gray Matter Volume

Condition	Brain Area	Anatomical Area	Cerebral hemisphere	Voxel	p
C-E	Occipital lobe	SupLOC	R	73	0.000
1	Occipital lobe	SupLOC	R	16	0.002
	Occipital lobe	SupLOC	R	38	0.005
	Temporal lobe	MTG	R	30	0.002
E-A	Frontal lobe	Precentral Gyrus	R	27	0.001
	Occipital lobe	Fusiform	R	22	0.000
	Subcutaneous tissue	Hippocampus	R	23	0.035

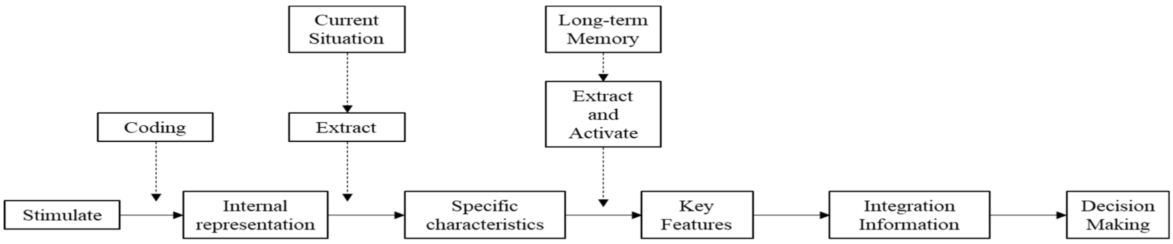

Figure 8. Schematic Diagram of Cognitive Processing

Discussion

(1) Differences in the structure of the brain

Many studies have shown that the function of the left and right hemispheres of the brain is asymmetric, the division of labor in cognitive function is strict and orderly. Generally, the left hemisphere focuses on abstract thinking such as language and logic analysis, while the right hemisphere focuses on image thinking such as space and imagination. So, the way that the two hemispheres process information is different. In this study, there is an obvious difference in the volume of gray matter in different brain regions of the right hemisphere between the employees of the innovative group and the employees of the ordinary group, which may be related to the long-term thinking and observation training of the employees of the innovative group, who, in the situations of practical application, observation and thinking under the long-term working environment, often need to carry out cognitive activities such as visual information processing and coordination with imagination to make decisions. As a result, the thickness of the cortex and the volume of the gray matter in the occipital region responsible for processing visual information will gradually change, and the change will become more significant over time.

(2) Plasticity of brain structure

It's shown that brain plasticity occurs not only in adolescence, when the brain is developing rapidly, but also in adulthood. The plasticity of brain plays an important role in the realization of brain function, and it can change with the increase of function. These changes mainly result from the new connections among neurons in cerebral cortex and the increase of gummy nerve cells. Studies have shown that people can influence the structure of the brain through both thinking and meditation exercises. After years of learning skills and thinking about normal work, employees with creative experience can select appropriate information from normal work environment and work situation and process relevant information so as to take effective decision-making behavior; however, ordinary employees are not so concerned about the working environment, and do not think about and integrate the information, and thus the information they get from the situation is disorderly, and thus they cannot extract useful and effective information to make decisions. The results show that the thickness of cortex and the volume of gray matter in the upper occipital lobe and lower temporal lobe regions are significantly higher in the innovative group than in the ordinary group. Therefore, it can be concluded that long-term brain training may result in a plastic change in the brain of an employee.

(3) Process of decision-making information processing

The general process of information processing includes input, storage, processing integration and output. From the perspective of cognitive psychology, the decision-making behavior in innovation management is a process of processing a series of information, and the concrete process is shown in the following Figure (8). This process shows that the employees with creative experience make decisions under a certain situation. Compared with the employees in ordinary group without creative experience, they can be more ready to perceive the information contained in the current situation, be more sensitive to the effective information, and then rapid and efficient process the information by transferring the relevant experience and knowledge information in the long-term memory.

Conclusions

In order to deeply study the decision-making behavior of enterprise employees in the context of innovation management, this study takes enterprise employees as research subjects, discusses the brain mechanism of decision-making behavior in innovation management with the help of scientific research methods and advanced instruments, and obtains the following research results:

(1) There is a certain difference in brain structure between the innovative employee group and the ordinary group, and it is mainly concentrated in the right hemisphere of the brain;

(2) The experimental results show that the thickness of cortex and the volume of gray matter on the lateral side of the occipital lobe of the right hemisphere of the innovative employee group are higher than those of the ordinary group. Therefore, the long-term thinking training and observation action produce a plastic change to the brain and an influence on the neural mechanism of the brain.

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