Application of Brain Science in English Classroom Design

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ABSTRACT

On the basis of students' English vocabulary learning, this study verifies the feasibility of Ebbinghaus' memory law and multi-sensory teaching method in English classroom design, in which the summary of memory accumulation and multi-sensory mobilization is closely related to the current results of brain science research. The design of English classroom should focus on the timing of providing new information and the frequency of reviewing old knowledge according to Ebbinghaus' forgetting curve, so as to help English learners convert the received information into long-term memory, in which the central word and the synonym / antonym memory method related to associative memory method can be adopted by the classroom designers. At the same time, reading, writing, listening and speaking multi-sensory transfer should also be promoted in teaching practice, since it not only promotes associative memory, but also helps learners keep their emotional cognition positive for a long time. The results of this study provide a theoretical basis for the application of brain science in English classroom design, and give some specific suggestions on how to implement it. On the one hand, it enlightens the practice of English education and provides a different teaching mode from the traditional one. On the other hand, it helps learners better understand the learning mechanism of the brain, and scientific learning methods help them improve their learning efficiency to achieve effect of higher quality learning.

Key Words: Brain Science, Multi-sensory Teaching Method, Emotional Cognition, English Classroom Design

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Introduction

The brain is the most advanced and potential organ of human beings, which has a complex and direct influence on English language learning. Different parts of the brain have different functions, and in terms of language learning, the frontal lobe participates in language expression, the occipital lobe is in charge of visual reading, the parietal lobe is related to reading ability, and the temporal leaf is in charge of hearing, language learning, and memory storage. In addition, the cerebellum affects cognition, innovation and emotion of human while the hippocampus controls the level of memory (Marinova-Todd *et al.,* 2000). According to language education theory, generally speaking, the left brain tends to deal with words, definitions and languages, and plays a vital role in the accumulation of early learning, while the right brain is better at dealing with the tone, speed and volume of communication, which is crucial in practical use. Therefore, the traditional language teaching is more inclined to the left-brain training, which is a wrong cognition in today's view since language learning is different from the traditional science, and emotional use in the learning process is also important.

The process of properly optimized language learning should include the following five steps: preparing, receiving information, refining and decomposing, accumulating memory and practical application.

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The preparing step includes related topic browsing and visual presentation of topics, building a basic knowledge framework for learners, and providing the possibility of communication for the brain in advance. The receiving information later is the process of finding connections among neurons in the brain and the formation of neural networks. The information will be transcoded in different ways in different functional partitions of the brain, and the multi-dimensional information corresponding to auditory and vision is the result of refinement and decomposition. The purpose of this step is to encourage the learner's in-depth understanding of the received information, while helping the formation of cumulating memory in the fourth stage. The formation of memory means that the establishment of the language neural network is completed, and the ingestion of new and similar language information can deepen and consolidate this step. The last step of practical application is the output of language learning results, which is the purpose of the whole language learning process. Taking English classroom design as an example, this study explores the mechanisms of memory accumulation and multi-sensory mobilization in brain learning in brain science, and gives practical suggestions for teaching practice.

English Learning is a Process That Based on Memory

For most learners, the mastery of the mother tongue does not require intentional and systematic learning, and the high-frequent use in daily life is sufficient to form a complete and powerful neural network. As far as language learning is concerned, neurons encode the content associated with it, so the number, frequency, and pattern of the survival of neurons, and effectiveness of signals depend on external stimuli. Learning a language can be more effective at certain time period. When the neural network of the mother tongue has been strong enough and perfect, it's more difficult for more novel foreign language to intervene (Graham, 1993). This may explain why the efficiency of English learning is higher and their learning effectiveness is better in terms of younger learners. But this is not absolute, and the neural network also can realize the elastic reorganization when diligent practice is performed after grasping a correct learning method. New learning content can facilitate the formation of new neurons, and increasingly complex neural networks will also become difficult to accept new learning content. Therefore, in English classroom design, it's necessary to arrange the teaching progress reasonably, and give consideration to the consolidation of the existing knowledge while imparting the new knowledge.

Mechanism of brain memory process

The process of learning English is the neural activity of the brain to acquire new information, while memory is the preservation of the acquired information to be read in later use. Therefore, memory is the deepening of learning, and is more important to English learning. The mechanism of brain memory process can be divided into biochemical mechanism and physiological mechanism. The former can be summarized as the synthesis of mRNA and protein, the production of neurotransmitters and the level of hormone. The experiments show that the learning experience and behavior are related to the mRNA in neurons, specifically, the synthesis of the controllable mRNA enzymes further affects the release of neurotransmitters and the synthesis of related proteins in the synapse site, and thus have a significant influence on the brain memory process. At the same time, a variety of neurotransmitters released by neurons in excitement, such as glutamate, have a significant effect on human memory. In addition, corticotropin can improve people's attention and stress ability, making language learning process easier, and consolidating and enhancing the process of memory. The physiological mechanism of brain memory mainly focuses on the specific location of memory activity in the brain (Rivard & Straw, 2000). The Working Process of Brain to Memory New Information as shown in figure 1.

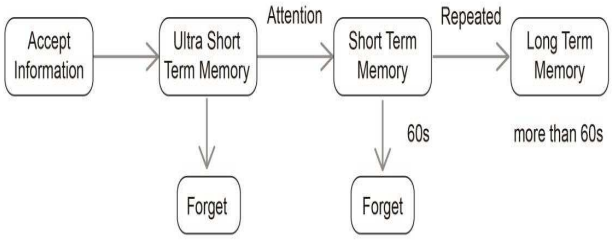

Figure 1. The Working Process of Brain to Memory New Information

Ebbinghaus' forgetting curve

Generally speaking, the memory of human brain can be divided into instantaneous memory, short-

Table 1. The Forgetting Regulation Given by Ebbinghaus

Time Interval	20 min	1 hour	8 hours	1 day	2 days	6 days	31 days
Memory Remained	58.2%	44.2%	35.8%	33.7%	27.8%	25.4%	21.1%

Table 2. Vocabulary Forgetting Outcome of Student A and Student B

Study Outcome	Student A			Student B		
	Understanding	Pronunciation	Spelling	Understanding	Pronunciation	Spelling
20 min	6	4	4	6	6	5
1 hour	5	4	3	5	4	4
8 hour	4	4	2	4	3	2
1 day	4	3	2	3	2	2
2 day	3	3	2	3	2	2
6 day	3	2	1	3	2	2
31 day	2	1	1	2	2	1

term memory and long-term memory. Among them, instantaneous memory is the direct result of external information stimulation and will disappear quickly if you don't think and study, but will change into short-term memory if you give enough attention (Werker and Tees, 2005). In the same way, short-term memory can be changed into long-term memory after constant repetition, whereas it can be forgotten, only the length of time the memory stays in the brain is different. The Forgetting Regulation Given by Ebbinghaus as shown in table 1.

Therefore, our ordinary learning and memory process is that the received information converts into short-term memory after people pay attention to and learn it, and into long-term memory with constant review. For English language learning, especially in the accumulation of words, the biggest difficulty is to overcome forgetting. Forgetting is periodic. With the increase in the number of times of reviewing, the forgetting period will gradually become longer. Therefore, learning English reasonably and scientifically according to the previous period can greatly improve the efficiency of English learning. At the same time, two students with the same level of English are taught with 10 new words to observe the forgetting law. Vocabulary Forgetting Outcome of Student A and Student B as shown in table 2.

The results of this study are generally consistent with Ebbinghaus' forgetting curve and his findings published in 1885. This curve (figure 2(a) and 2(b)) shows the rule of forgetting in general English learning, and the peak of forgetting is in the short term when new knowledge is accepted, but the forgetting slows down after a long time, that's, the newly formed memory is easier to forget than the long-formed memory.

Associative memory method

In addition to the discovery of memory forgetting periods, Ebbinghaus also found that in English learning, there is a great difference between memory on the basis of understanding and meaningless memory (Garcia-Sierra *et al.,*2011). The following results show that meaningful content such as words and poetry is easier to remember, while meaningless content is not only more time-consuming to remember, but also less likely and accurate to recall later. Compare and Contrast of The Forgetting Outcome Between Meaningful and Meaningless Syllable as shown in table 3.

Therefore, teachers in English classroom should pay more attention to guide students to correctly understand the new knowledge. This deep and detailed analysis, processing and understanding of its deep meaning is a strategy to promote slow forgetting of memory. Specific measures include supplementing details, giving examples, associating, etc. The mining of deep information can provide more ways for the retrieval of memory and more information for the establishment of neural network. The key to this strategy is to relate the accumulated experience to the new information to be received and give it a more vivid meaning. The associative memory reflects the objective connection in receiving the knowledge and can fully promote the formation of memory and mental activities such as imagination thinking. Ebbinghaus Forgetting Curve and forgetting Curves of Student A and Student B Based on The Vocabulary Understanding as shown in figure 2.

Table 3. Compare and Contrast of the Forgetting Outcome between Meaningful and Meaningless Syllable

Memory Object	Repeated Time
12 meaningless syllable	16.5
36 meaningless syllable	54
480 syllable in a poem	8

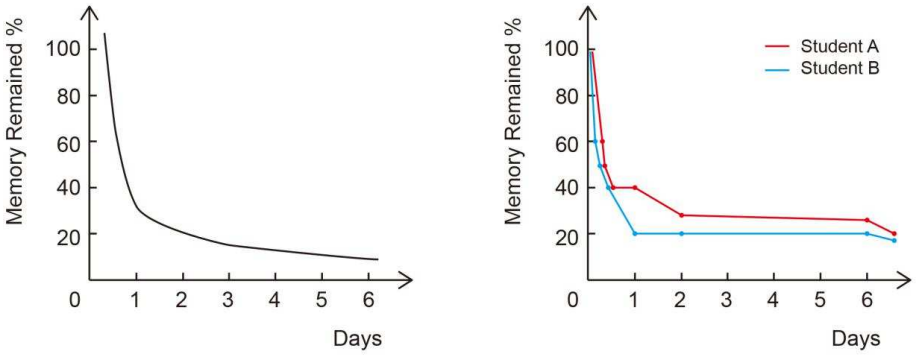

Figure 2. (left). Ebbinghaus Forgetting Curve; (right). Forgetting Curves of Student A and Student B Based on The Vocabulary Understanding

(1) Core lexicon association

Start with a core word, and continue to associate with extended classification, similar to the growing branches of a tree trunk, and whichever leaf will eventually associate with the most central branch. The core lexicon association method lies in the inductive classification. The finer the classification is, the higher the vocabulary appears, and the lower the corresponding frequency of use will be. The Central Vocabulary Association Method with the Case of Word Human as shown in figure 3.

(2) Synonym/antonym association

Different from the core word association, this association mode pays more attention to the orientation of the meaning of English words. In many situations where English is used, it's necessary to understand most words accurately, so the synonym/antonym association memory method can help us to judge the meaning when the memory is vague. The Synonyms/Antonym Association Method with the Case of Word Good as shown in figure 4.

English Learning Should Coordinate Multiple Sensory Abilities

Consistency of the memory by different senses

Learning about language should be multi-sensory, which requires different brain regions to link up in the process of neural network formation. If the visual information of a language is forgotten, but the appearance of auditory information may recall that part of the forgotten visual information. In the process of English learning, the combination of listening and speaking can make the visual cortex with brain electrical activity in the later

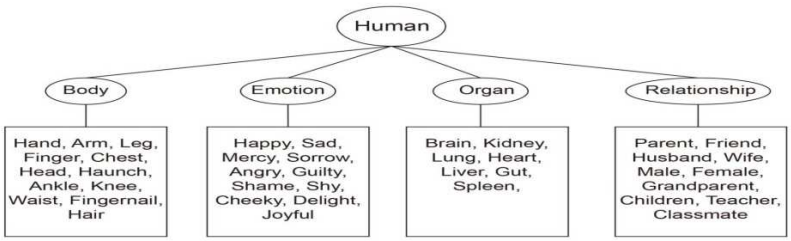

Figure 3. The Central Vocabulary Association Method with the Case of Word Human

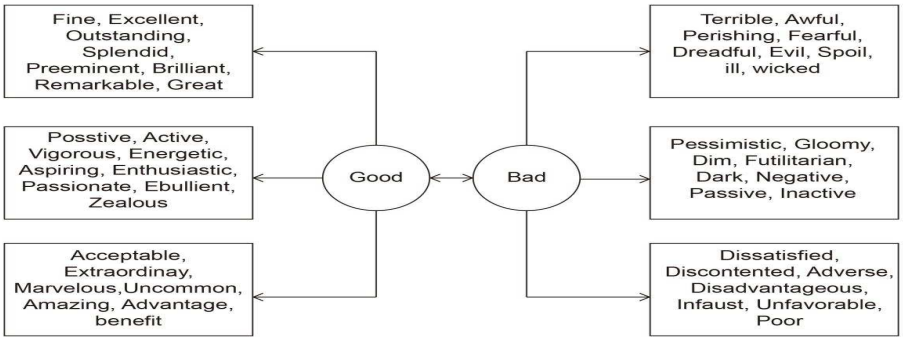

Figure 4 . The Synonyms/Antonym Association Method with the Case of Word Good

Table 4. Specific Vocabulary Forgetting Outcome of Student B after 8 Hours and 6 Days

Study Outcome	Student B (After 8 hours)			Student B (After 6 days)		
	Understanding	Pronunciation	Spelling	Understanding	Pronunciation	Spelling
1.Word A	Mistake	Wrong	Wrong	Wrong	Wrong	Wrong
2.Word B	Right	Mistake	Mistake	Mistake	Wrong	Wrong
3.Word C	Mistake	Wrong	Wrong	Mistake	Wrong	Wrong
4.Word D	Right	Right	Right	Right	Right	Right
5.Word E	Wrong	Wrong	Wrong	Wrong	Wrong	Wrong
6.Word F	Right	Right	Mistake	Right	Mistake	Mistake
7.Word G	Wrong	Wrong	Wrong	Wrong	Wrong	Wrong
8.Word H	Right	Right	Right	Right	Right	Right
9.Word I	Mistake	Wrong	Wrong	Mistake	Wrong	Wrong
10.Word J	Wrong	Wrong	Wrong	Wrong	Wrong	Wrong

application stage though only involving auditory information, and the brain's multi-sensory representation information can be activated by a single sensory information (Kuhl *et al.,*2006). At the same time, the brain's ability to automatically fill in incomplete information received from the outside world determines that multi-sensory learning can achieve better English learning. According to the above-mentioned experiment of verifying Ebbinghaus' forgetting curve, a further analysis on the forgetting of the word learning results of the student B after 8 hours and 6 days can verify that the forgetting degree of the same word, meaning, pronunciation and spelling tends to be consistent. Specific Vocabulary Forgetting Outcome of Student B after 8 Hours and 6 Days as shown in table 4.

Coordination of multiple senses can affect emotional cognition

Not all information can be noticed by the brain, most external stimuli are merely transient memories for humans, and only information that is meaningful to learners and resonates emotionally can be perceived (Kuhl *et al.,*2003). The learning mechanism of the brain is to construct the process of individual cognition in a systematic way through the understanding and processing of external information under the impetus of emotion. Therefore, good emotional cognition can improve the efficiency of English learning. In the process of English learning, the meaningful information for the learners will be temporarily stored as short-term memory in the prefrontal lobe of the brain. When the learners is very angry or anxious under the emotional instability, the neurons in the emotional center of the brain will become extremely negative, which is disadvantageous to the establishment of neural network and the formation of long-term memory (Turnbull, 1995). Therefore, it is very important to create a relaxed and pleasant learning atmosphere through the mobilization of learners' multi-senses. At the same time, the multi-sense teaching method can avoid boring classroom and help to keep learners' attention. When the English teaching mode is not changed, repeated and similar information will cause the brain cortex to withdraw from the active state, and the loss of attention is not conducive to the transition from short-term memory to long-term memory.

Multi-sensory English teaching

Human multi-senses are generally divided into hearing, vision, touch, smell and taste, through which the brain receives external stimuli to achieve communication and exchange. Multi-sensory English teaching is mainly to help students understand new knowledge better by arousing the enthusiasm of these five senses, and to establish efficient neural networks to form long-term memory. The research shows that 65% of English learning experience accumulation comes from the transmission of visual information, 25% depends on the reception of auditory information, and only 10% comes from the touch, with the contribution of touch, smell and taste to English learning neglected (Edelman, 2006). Therefore, the practice of English learning mainly depends on vision and hearing. In the process of English teaching, we should add multi-sensory clues, mainly based on visual and auditory information.

(1) Visual English teaching strategy

In English teaching practice, if relevant examples, image information or film and television materials can be added, it can help learners to understand the language information correctly, and establish the connection of auditory visual information. Therefore, the teachers can arouse the enthusiasm and interest of the learners by giving

the visual information, such as a variety of teaching modes, performance of drama or other exaggerated body movements, information display of network multimedia, or the arrangement of rich and varied teaching environment. At the same time, attention should be paid to guiding learners to observe, think and feedback the essential connection between visual information and revived language information, so as to form accurate and long-term memory.

(2) Auditory English teaching strategy

Auditory information is also one of the main ways to input information in English learning. The auditory information that can be added in English teaching practice mainly includes audio play, vocalization practice and pronunciation and intonation. Reading the text is likely to be more interactive than one-way input of audio playback. The brain controls the vibration of vocal cords according to EEG signals from the memory stored in the neural network, while the ears receive the auditory information emitted by itself, which is re-encoded by the cerebral cortex which controls the auditory, forming another stimulus to the neural network (Davidson, 2011). Voice and intonation, as higher level auditory information, not only emphasizes the accurate transmission of information, but also tends to emotional understanding. The practice of language cannot be separated from the actual scene and depends on the mutual communication of emotions. Therefore, as a more advanced and delicate language information, pronunciation and intonation are obviously important.

Conclusions

Unlike native language learning, English as a foreign language lacks a high-frequent learning environment, so scientific method guidance is very important for English learning. The English class designed according to the operation mechanism of the brain can fully arouse the enthusiasm of teachers and students, create a positive and active classroom atmosphere, and also achieve higher quality and high efficient teaching results. In the process of learning, the operation mechanism of the brain is very complicated. This study only focuses on the process of memory forgetting and multi-sensory coordination in brain science, and puts forward some practical suggestions on the design of English classroom. In teaching practice, repeated attention to information received by the brain is the key to transforming short-term memory into long-term memory. Only long-term memory stored in neural network can be used skillfully in practical scenes, and associative memory can be used in English classroom design. At the same time, the results of English learning should be multi-dimension output, and the listening, speaking, reading and writing should not be separated from each other. Therefore, in the process of English teaching, we should make full use of the various senses of the learners, which can not only promote the formation of long-term memory, but also make full use of the emotion cognition of learners. Educational practitioners should make more specific adjustments to classroom design according to the specific conditions of the students. English learning is a lifelong learning process, which should follow the objective laws of brain science, with scientific learning methods and diligent practice, instead of rushing to success.

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