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Cognitive Benefits of Language Learning

Selected Articles

Cognitive Benefits of Bilingualism/Second Language Learning

▪ **Foster, K. M., & Reeves, C. K. (1989). Foreign Language in the Elementary School (FLES) improves cognitive skills. *FLES News, 2*(3), 4.**

> This study looks at the effects of an elementary school foreign language program on basic skills by looking at the relationship between months of elementary foreign language instruction in French and scores on instruments designed to measure cognitive and metacognitive processes. The study included 67 sixth-grade students who were divided into four groups that differed by lengths of time in the foreign language program. There was a control group of 25 students who had no French instruction and three groups of students who had participated in the program for different lengths of time (6.5 months, 15.5 months, and 24.5 months). The students who did receive foreign language instruction had received 30 minutes of French instruction daily after 30 minutes of basal reading in English. The control group received an additional 30 minutes of reading instruction in place of foreign language instruction. The results of the analysis showed that the groups who received foreign language instruction scored significantly higher in three areas (evaluation on the Ross test, total score of all cognitive functions on Ross test, and total score on Butterfly and Moths test) than the control group. **In particular, the students who had received foreign language instruction scored higher on tasks involving evaluation which is the highest cognitive skill according to Bloom's taxonomy. The linear trend analysis showed that the students who had studied French the longest performed the best.**

▪ **Landry, R. G. (1973). The enhancement of figural creativity through second language learning at the elementary school level. *Foreign Language Annals, 7*(1), 111-115. from Linguistics and Language Behavior Abstracts database.**

> The main hypothesis of this study is that the experience of learning a second language at the elementary school level is positively correlated to divergent thinking in figural tasks. This study is concerned with flexibility in thinking through experience with a foreign language. Comparisons are made between second language learners and single language learners. **The second language learners score significantly higher than do the monolingual students. Second language learning appears, therefore, not only to provide children with the ability to depart from the traditional approaches to a problem, but also to supply them with possible rich resources for new and different ideas.**

▪ **Hakuta, K. (1985). *Cognitive development in bilingual instruction*. U.S.; Virginia:**

> Theory and research on bilingualism and its relationship to cognitive development have provided mixed results, especially in relation to the value of United States bilingual education programs. Little of the existing research on bilingualism is generalizable to U.S. minority language groups. **However, one study of children in a bilingual program designed to see if intellectual abilities are related to the student's degree of bilingualism rather than to compare bilingual and monolingual children found that a positive relation exists between bilingualism and various abilities, such as the ability to think abstractly about language and to think nonverbally.** In addition, the correlation between the students' abilities in the two languages developed in the bilingual education

program became stronger in the course of the program, supporting the idea of the interdependence of the languages of the bilingual.

▪ **Ricciardelli, L. A. (1993). An investigation of the cognitive development of Italian-English bilinguals and Italian monolinguals from Rome. *Journal of Multilingual and Multicultural Development, 14*(4), 345-346. from Linguistics and Language Behavior Abstracts database.**

The cognitive development of Italian-English bilingual & Italian monolingual children (aged 5-6) was studied based on measures of metalinguistic awareness, creativity, nonverbal abilities, & reading achievement. Following proficiency testing in both languages, students were assigned to groups of high & low Italian proficiency & high & low English proficiency, producing six groups for comparison. **Results of comparison of performance on the measures of cognitive development indicated that students who demonstrated high proficiency in both English & Italian achieved higher scores on the creativity, metalinguistic awareness, & reading achievement tests**

▪ **Rodriguez, Y. G. (. (1992). The effects of bilingualism on cognitive development. (EdD, ProQuest Information & Learning/Temply University). *Dissertation Abstracts International, 53* (4-A), 1104.**

It was the primary purpose of this study to investigate the effects of bilingualism on the cognitive development and linguistic performance of children at various ages living in the same cultural environment. It also studied the relationship between formal operational thought and a prerequisite cognitive style as typified by field independence/field dependence for both bilingual and monolingual subjects. The bilingual subjects were tested for both language dominance and language proficiency. To investigate the interrelationships between bilingualism and cognitive function, it was necessary to include both verbal and non-verbal tests of cognition. No significant differences in performance could be attributed to lingualism, grade, or age with the exception of language proficiency correlated with cognitive level on analytical reasoning. The childrens' overall cognitive level indicated some justification for the theoretical relationship between verbal and non-verbal measures of abstract thinking. **The bilingual children used higher order rules more frequently than the monolingual children. The evidence seems to suggest that bilingualism may scaffold concept formation and general mental flexibility.**

▪ **Bialystok, E. (1999). Cognitive complexity and attentional control in the bilingual mind. *Child Development, 70*(3), 636-644. from PsycINFO database.**

Investigates whether the bilingual advantage in control (selective attention) can be found in a nonverbal task, the dimensional change card sort, used by P. D. Zelazo and D. Frye (e.g., 1997) to assess Cognitive Complexity and Control (CCC). The author contends this problem contains misleading information characteristic of high-control tasks but minimal demands for analysis. 60 preschool children, half of whom were bilingual, were divided into a group of younger (mean age 4.2 yrs) and older (mean age 5.4 yrs) children. All the children were given a test of English proficiency (PPVT-R; L. M. Dunn and L. M. Dunn, 1981) and working memory (Visually-Cued Recall Task) to assure comparability of the groups and then administered the dimensional change card sort task and the moving word task. **The bilingual children were more advanced than the monolinguals in the solving of**

experimental problems requiring high levels of control. It is concluded that these results demonstrate the role of attentional control in both these tasks.

▪ **Mohanty, A. K. (1992). Bilingualism and cognitive development of kond tribal children: Studies on metalinguistic hypothesis. *Pharmacopsychoecologia.Special Issue: Environmental Toxicology and Social Ecology, 5*(1-2), 57-66. from PsycINFO database.**

Bilinguals' superiority over unilinguals on cognitive, linguistic, and academic achievement measures has been explained in terms of a metalinguistic hypothesis that suggests that use of 2 or more languages endows the language users with special awareness of objective properties of language and enables them to analyze linguistic input more effectively. A series of studies compared unilingual and balanced bilingual Kond children to investigate the metalinguistic hypothesis. **These studies show that the bilinguals outperform the unilinguals on a number of cognitive, linguistic, and metalinguistic tasks, even when the differences in intelligence are controlled.** However, a study with unschooled bilingual and unilingual children showed no significant differences in metalinguistic skills. The metalinguistic hypothesis of bilinguals' superiority in cognition may need to be reexamined in the context of the effect of schooling on metalinguistic processes.

Learning, Memory, and Language

LEARNING AND MEMORY.

A major breakthrough in understanding how the brain accomplishes learning and memory began with the study of a person known by his initials, H.M. As a child, H.M. developed a severe and intractable epilepsy, and an experimental surgical treatment involving removal of the medial regions of his temporal lobes greatly alleviated the seizures. However, the surgery left H.M. with severe amnesia. He can remember recent events for only a few minutes and is unable to form explicit memories of new experiences. Talk with him awhile, and then leave the room. When you return, he has no recollection of ever having seen you.

Despite his inability to remember new information, H.M. remembers his childhood very well. From these observations, researchers concluded that the parts of H.M.'s medial temporal lobe that were removed, including the hippocampus and *parahippocampal region*, play critical roles in converting memories of experiences from short-term memories to long-term, permanent memories. The fact that H.M. retains some memories for events that occurred long before his surgery indicates that the medial temporal region is not the site of permanent storage but instead plays a role in the organization and permanent storage of memories elsewhere in the brain.

The medial temporal region is richly connected to widespread areas of the cerebral cortex, including the regions responsible for thinking and language. Whereas the medial temporal region is important for forming, organizing, consolidating, and retrieving memory, cortical areas are important for the long-term storage of knowledge about facts and events and for how this knowledge is used in everyday situations.

Our ability to learn and consciously remember everyday facts and events is called *declarative memory*. Studies using functional brain imaging have identified a large network of areas in the cerebral cortex that work together to support declarative memory. These cortical areas play a distinct role in complex aspects of perception, movement, emotion, and cognition.

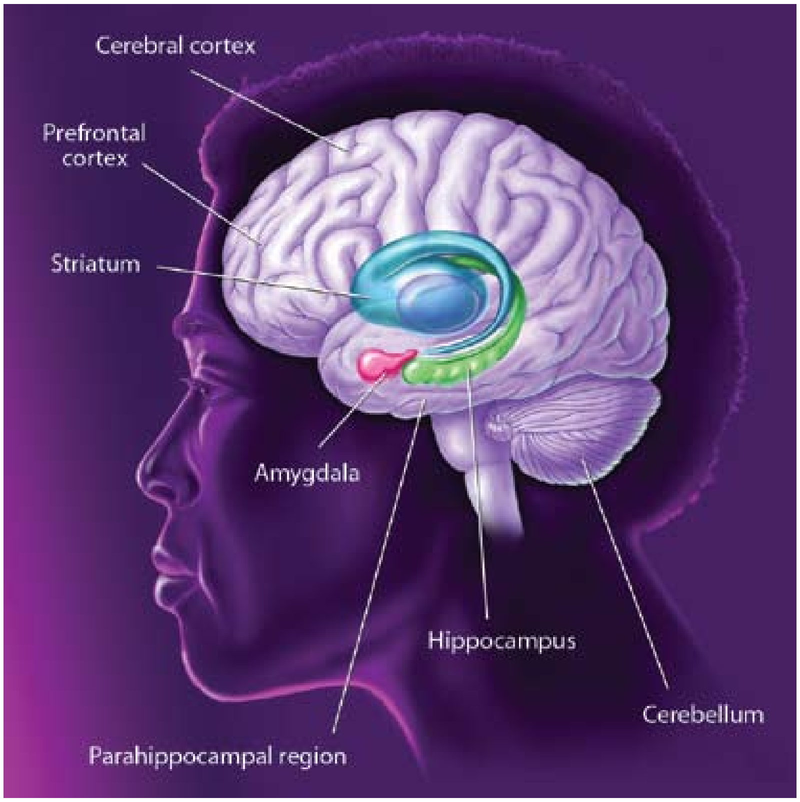
When we have new experiences, information initially enters *working memory*, a transient form of declarative memory. Working memory depends on the prefrontal cortex as well as other cerebral cortical areas. Studies on animals have shown that neurons in the *prefrontal cortex* maintain relevant information during working memory and can combine different kinds of sensory information when required. In humans, the prefrontal cortex is highly activated when people maintain and manipulate memories.

Distinct areas within the prefrontal cortex support *executive functions*, such as selection, rehearsal, and monitoring of information being retrieved from long-term memory. To serve these functions, the prefrontal cortex also interacts with a large network of posterior cortical areas that encode, maintain, and retrieve specific types of information, such as visual images, sounds, and words, as well as where important events occurred and much more.

Semantic memory is a form of declarative knowledge that includes general facts and data. Although scientists are just beginning to understand the nature and organization of cortical areas involved in semantic memory, it appears that different cortical networks are specialized for processing particular kinds of information, such as faces, houses, tools, actions, language, and many other categories of knowledge. Studies using functional imaging of normal humans have revealed zones within a large cortical expanse that selectively process different categories of information, such as animals, faces, or words.

Our memories of specific personal experiences that happened at a particular place and time are called *episodic memories*. It is generally believed that the medial temporal lobe areas serve a critical role in the initial processing and storage of these memories. Studies have shown that different parts of the parahippocampal region play distinct roles in processing "what," "where," and "when" information about specific events. The hippocampus links these elements of an episodic memory. The linkages are then integrated back into the various cortical areas that represent the details of each type of information.

> *How exactly are memories stored in brain cells? After years of study, much evidence supports the idea that memory involves a persistent change in synapses, the connections between neurons.*



LEARNING AND MEMORY. Different brain areas and systems mediate distinct forms of memory. The hippocampus, parahippocampal region, and areas of the cerebral cortex (including prefrontal cortex) compose a system that supports declarative, or cognitive, memory. Different forms of nondeclarative, or behavioral, memory are supported by the amygdala, striatum, and cerebellum.

The fact that H.M. and other people with amnesia show deficits in some types of memories and not others indicates that the brain has multiple memory systems supported by distinct brain regions. *Nondeclarative knowledge*, the knowledge of how to do something, is expressed in skilled behavior and learned habits and requires processing by the basal ganglia and cerebellum. The cerebellum is specifically involved in motor tasks that are time-dependent. The amygdala appears to play an important role in emotional aspects of memory attaching emotional significance to otherwise neutral stimuli and events. The expression of emotional memories involves the hypothalamus and sympathetic nervous system, which support emotional reactions and feelings. Thus, the brain appears to process different kinds of information in separate ways.

How exactly are memories stored in brain cells? After years of study, much evidence supports the idea that memory involves a persistent change in synapses, the connections between neurons. In animal studies, researchers found that this occurs in the short term through biochemical events that affect the strength of the relevant synapses. Turning on certain genes may lead to modifications within neurons that change the strength and number of synapses, stabilizing new memories. Researchers studying the sea slug *Aplysia californica*, for example, can correlate specific chemical and structural changes in relevant cells with several simple forms of memory that the animal shows.

Another important model for the study of memory is the phenomenon of *long-term potentiation* (LTP), a long-lasting increase in the strength of a synaptic response following stimulation. LTP occurs prominently in the hippocampus, as well as in the cerebral cortex and other brain areas involved in various forms of memory. LTP occurs through changes in the strength of synapses at contacts involving N-methyl-d-aspartate (NMDA) receptors.

Subsequently, a series of molecular reactions plays a vital role in stabilizing the changes in synaptic function that occur in LTP. These molecular events begin with the entry of calcium ions into the synapse, which activates the cyclic adenosine monophosphate (cAMP) molecule. This molecule activates several kinds of enzymes, some of which increase the number of synaptic receptors, making the synapse more sensitive to neurotransmitters. In addition, cAMP activates another molecule, called cAMP-response element binding protein (CREB). CREB operates within the nucleus of the neuron to activate a series of genes, many of which direct protein synthesis. Among the proteins produced are neurotrophins, which activate growth of the synapse and increase the neuron's responsiveness to stimulation.

Many studies have shown that the molecular cascade leading to protein synthesis is not essential to initial learning or to maintaining short-term memory; however, this cascade is essential for long-term memory. In addition, studies using genetically modified mice have shown that alterations in specific genes for NMDA receptors or CREB can dramatically affect the capacity for LTP in particular brain areas, and the same studies have shown that these molecules are critical to memory.

The many kinds of studies of human and animal memory have led scientists to conclude that no single brain center stores memory. It most likely is stored in distributed collections of cortical processing systems that are also involved in the perception, processing, and analysis of the material being learned. In short, each part of the brain most likely contributes differently to permanent memory storage.

Language

One of the most prominent human abilities is language, a complex system involving many components, including sensory-motor functions and memory systems. Although the neural basis of language is not fully understood, scientists have learned a great deal about this function of the brain from studies of patients who have lost speech and language abilities owing to stroke, and from brain imaging studies of normal people.

It has long been known that damage to different regions within the left hemisphere produce different kinds of language disorders, or aphasias. Damage to the left frontal lobe can produce nonfluent aphasias, such as *Broca's aphasia*, a syndrome in which speech production abilities are impaired. Speech output is slow and halting, requires effort, and often lacks complexity in word or sentence structure. By comparison, comprehension of heard speech is spared, although structurally complex sentences may be poorly understood.

Damage to the left temporal lobe can produce fluent aphasia, such as *Wernicke's aphasia*, in which comprehension of heard speech is impaired. Speech output, although of normal fluency and speed, is often riddled with errors in sound and word selection and tends to be unintelligible gibberish.

Damage to the superior temporal lobes in both hemispheres can produce *word deafness*, a profound inability to comprehend auditory speech on any level. Whereas Wernicke's aphasics can often comprehend bits and pieces of a spoken utterance and can comprehend isolated words, patients with word deafness are functionally deaf for speech, lacking the ability to comprehend even single words, despite being able to hear sound and even identify the emotional quality of speech or the gender of the speaker.

Research on aphasia has led to several conclusions regarding the neural basis of language. Researchers once believed that all aspects of language ability were governed only by the left hemisphere. Recognition of speech sounds and words, however, involves both left and right temporal lobes. In contrast, speech production is a strongly left-dominant function that relies on frontal lobe areas but also involves posterior brain regions in the left temporal lobe. These appear to be important for accessing appropriate words and speech sounds.

Recently, functional imaging methods have identified new structures involved in language. For example, systems involved in accessing the meaning of words appear to be located (in part) in the middle and inferior portions of the temporal lobe. In addition, the anterior temporal lobe is under intense investigation as a site that may participate in some aspect of sentence-level comprehension.

Recent work has also identified a sensory-motor circuit for speech in the left posterior temporal lobe, which is thought to translate between speech recognition and speech production systems. This circuit is involved in speech development and is thought to support verbal short-term memory.

Although the understanding of how language is implemented in the brain is far from complete, there are now several techniques that may be used to gain important insights into this critical aspect of brain function.

How The Brain Organizes Language

NEW YORK, July 09 (Reuters) -- Researchers have discovered that the age at which a second language is acquired determines just where that language is 'stored' within the brain.

"A second language acquired during the teenage years, which is late in developmental life, is represented in the brain in a separate location from the native language," says Dr. Joy Hirsch, a professor of neuroscience at New York's Memorial Sloan-Kettering Cancer Center, and senior author of a study published in the current issue of the journal Nature. "But when both languages are learned at the same time early in life, they are represented in areas that have a considerable amount of overlap."

Hirsch used an advanced brain-imaging technology called functional magnetic resonance imaging (fMRI) to observe activity patterns within the brains of 12 fluently bilingual study subjects.

Six of the subjects had learned two languages in early childhood, while the other six had picked up a second language during their teenage years.

Each subject was placed within the fMRI scanner, and asked to engage in a silent, internal monologue about the previous day's events, conducted in each of their acquired languages. The researchers asked the subjects not to speak aloud, since this can cause small head movements which obscure fMRI readings.

Neurologists believe language and speech functions are concentrated in two specific areas of the brain: Wernicke's area, located in the left temporal lobe (sited just over each ear), and Broca's area (in the left frontal lobe of the brain). Broca's area is thought to play a role in our ability to speak, while Wernicke's area assists in understanding words spoken to us.

Looking at the fMRI pictures, the study authors discovered that "in both late and early bilingual subjects, Wernicke's area... show(s) effectively little or no separation of activity based on the age of language acquisition."

However, scans of Broca's area revealed a different picture. "Within... Broca's area, second languages acquired in adulthood ('late' bilingual subjects) are spatially separated from native languages."

This meant that when a particular study subject thought in his mother tongue (for example, English), the fMRI scan registered activity in a particular spot within Broca's area. When asked to think in the French he acquired in high school, a separate area stirred into action.

However, for those who became bilingual as toddlers, "native and second languages tend to be represented in common... areas," of the Broca's area, researchers say.

It's still not clear just why child and adult language acquisition take such divergent neurological paths. But Hirsch and her colleagues speculate that infants, with relatively 'plastic', still-developing brains, may easily adapt to two incoming language patterns, incorporating both into the same storage space within Broca's area. But after the passage of early childhood, that area may become less malleable and, as the researchers say, "not subsequently modified." They believe "this could necessitate the utilization of adjacent... areas for the second language learned as an adult."

Hirsch believes her research could have a real benefit for Sloan-Kettering's cancer patients. In fact, she initiated her research with those individuals in mind. Twenty-five percent of all brain tumors occur in and around speech-sensitive areas of the brain. Surgeons must be extremely careful in excising tumors, to try to minimize damage to the patient's language capability.

"Based on the results of the current study, we always ask our patients whether they speak more than one language," said Hirsch's colleague and study lead author Dr. Karl Kim. "If they do, both languages need to be mapped to acquire a complete picture of language-sensitive areas of the brain."

SOURCE: Nature (1997,388(10):171-174)

A Dozen Activities for Promoting the Use of Spanish Outside of School

The ACIE Newsletter, November 1997, Vol. 1, No. 1

Submitted by David Downs-Reid, Instructional Assistant Robbinsdale Spanish Immersion, Robbinsdale, MN
Adapted from a list compiled by Laura Pezan, 1st grade teacher at Robbinsdale Spanish Immersion, Robbinsdale, MN

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1) Check out books and audiotapes at your local public library or invest in books/audiotapes that are written in Spanish. (Books are available at Barnes & Noble, through Scholastic and Troll book orders, book fairs at school, and other sources.)

2) Designate a time for daily family reading and/or silent reading. Encourage your child to read something in Spanish as well as English.

3) Invite a classmate/schoolmate over to have a special "Spanish evening" or "Spanish night over."

4) Let your child call a student from the immersion school to speak Spanish on the phone.

5) Host a teacher's assistant (T.A.) from Mexico or be an "Aunt and Uncle" family and invite a T.A. over for dinner or a party, or include a T.A. in a family outing.

6) Give your child the necessary supplies to write letters to Spanish-speaking families and/or friends from school. Get on the "super highway" by using the Internet to speak with others who can communicate in Spanish - parent supervision is advised.

7) Use your child's Spanish writing skills to write to the embassies or offices of tourism of Spanish-speaking countries. Request information, pamphlets, posters, postcards, booklets about the country. Use the information to make your own travel guide, mural, poster, etc.

8) Visit a Latino market in your community. Cheer your child on as s/he helps you purchase your food in Spanish.

9) Talk about the reasons why you want your child to learn another language and ask your child why s/he thinks it is important to know a second language.

10) Recognize, praise and encourage any efforts your child makes to speak Spanish. Often, just the vocalization of our pride in his or her efforts can make the difference.

11) Review the songs and poems that your child sings and recites at school. Your child can sing the song or recite the poem alone by memory, then ask him or her to teach you a song or poem. Let your child be the singing entertainment on your next road trip!

12) Purchase children's videos, music and software programs in Spanish. Call the company "Niños" at 1-800-634-3304 for a catalog. Blockbuster video stores will order Disney videos in Spanish for purchase upon request.

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