The Bilingual Brain

What Key Studies are Showing

American Language Review

What really happens when a learner switches from one language to another? Does it enhance learning or interfere? Is the age of acquisition a significant factor? For what aspects of language? Does aging affect language skills in native(L1) or second(L2) languages? Are there issues related to the development of language that are independent of acquiring or speaking a second language? How might we engineer circumstances which allow the language areas of the brain to function most efficiently? Does priming influence language fluency? All of these are questions researchers have been investigating. Educators may be interested in the latest findings.

Although we cannot yet claim direct teaching prescriptions based on findings in brain studies, the literature does provide clues toward a better understanding of learning and language development. We can make significant inferences to inform methods and practice. This article addresses research findings of localization, age of acquisition, plasticity, switching, priming and L1/ L2 language development issues.

The localization of language(s). Kim, et. al., in a 1997 study worked to identify distinct cortical areas associated with native and second languages. Twelve multilingual subjects were divided into two groups, six having acquired a second language from infancy and six who acquired the second language in early adulthood (after age twelve or “late” language learners). Each subject was placed in a functional magnetic resonance imaging (fMRI) machine and was then asked to silently, internally “ talk” to themselves in response to a prompt, first in their L1, then their L2. The fMRI (assessing brain area activation) showed representations in the left temporal lobe of the brain (Wernicke's area) that were activated during native and second language use, respectively.

The results showed distances between centers of activity to be seven times further apart for late acquisition bilinguals. Additionally, the areas of overlapping activity were much greater for early bilinguals. Many inferences have resulted from Kim's work. The primary and often referenced conclusion is that these findings support a “critical period” hypothesis for language acquisition. Due to the distancing between language centers and less overlapping area in late bilinguals, people often conclude that this substantiates the argument for early foreign language instruction. Though early acquisition of a L2 appears to require less cellular area than in late acquisition, the study simply cannot suggest anything more, without further study.

From the perspective of the classroom practitioner working with English language learners, this information begins to shed light on a known convention in the field: That late second-language learners will speak with a discernible accent. Common belief has it that a student who does not begin to learn L2 before age twelve will never be able to articulate that language like a native speaker. At the root, this is because a “ sensitive” period exists for the development of phonemic awareness - the ability to distinguish the individual phonemic sounds associated with a spoken language - has not been adequately embedded.

But new evidence suggests it is now possible to correct this deficit. In a recent study, adult Japanese speakers of English, who did not have phonemic awareness of the sounds associated with the letters `l' and `r', and therefore could not pronounce those phonemes correctly, were taught to clearly pronounce these sounds. By separating the sound into smaller segments and being shown the

correct positioning of the tongue for the pronunciation of each sound, these L2 students were able to train their brains to distinguish these phonemes, thus allowing their pronunciation.
Beyond this, there appears to be no other salient inferences for second-language acquisition which can be drawn from Kim's findings. We cannot say with any assurance that the differences found in location of brain activity for native speakers and late bilinguals shows any significant cognitive or physical attributes other than the spoken accent. Further, the evidence from the work with adult Japanese subjects suggests that the plasticity of the brain, that is its ability to adapt and change according to new demands, shows the sensitive period can be overcome. Both early and late language learners have the capacity to learn, comprehend and fluently speak a second language-independent of the distance the centers of activity reside in the brain.

Katherine Kohnert, et. al. explored Spanish/English bilinguals from 5 years of age to college students. All subjects were from Spanish speaking families. She measured the accuracy and response time of participants responding to a series of prompts in each language (“say” or “ diga”) in a blocked condition (all English or all Spanish sequences).

While providing pictures of common items (bed, pencil, bench) her findings showed significantly slower processing speed with increases of age, coupled with a corresponding decline in errors. Younger children (5-7 yrs.) performed more accurately in Spanish, giving way to more accuracy in English by early adolescence. However, all participants were faster responding in English.

Kohnert, et. al.'s study suggested that during the middle years of youth there is a balancing of performance in both accuracy and speed, which is lost in adolescence as spheres of influence shift form home to school, and to the majority speaking culture.

Kohnert, Hernandez and Bates took 100 bilinguals of Mexican-American decent and had them name pictures in both English and Spanish. Using a list of words (Boston Naming Test) ordered from simple to difficult (bed to abacus) and from frequently used to less used, they administered the list of 60 pictures, asking subjects to name them in each language. They found that all subjects scored better in English (avg. 46 of 60) than in Spanish (avg. 32 of 60). From this they suggest that lexical items (as in words) do not always share the same lexical-semantic frequency cross-linguistically or cross-culturally.

They further comment that the ability to understand Spanish-speaking family members remains despite immersion in an English-language educational setting. However, the ability to read and write in Spanish may suffer. There may also be some erosion in the ability to speak Spanish as fluently. More importantly they astutely note, the heterogeneity of the Spanish-English bilingual population in the U.S. is considerable. Educational level, dialect, country of origin, geographical location, socioeconomic status, gender, age, proficiency of each language, and context and age of acquisition of each of the languages must all be considered in the assessment of language skills.”

Again, we find that the evidence from the research reinforces the conventional wisdom of the classroom practitioner: L2 students will learn the basic language needed to survive in social settings before they master the academic language of school. Often, as they earn acceptance in the social setting of school through the use of L2, they will begin to distance themselves from L1 in favor of their new language. Use of L1 in the home may continue, but as time progresses, the student will develop mastery in L2 that may exceed his/her proficiency in L1.

A related phenomena exists in the development of literacy in L2. Children who come to school from minority-language backgrounds without literacy in the native language will struggle to develop literacy in L2. This type of student benefits most from a bilingual pedagogy that teaches him/her literacy in L1 before or at the same time as L2 literacy. A student who comes to school with literacy skills in L1 will

be able to acquire a similar level of literacy in L2 in a reasonable period of time (usually 3-5 years). This type of learner benefits more from a pedagogical approach centered around literacy development in L2 combined with enrichment in L1.

Arturo Hernandez, et. al. studied six early bilinguals averaging 23 years of age. The purpose was to focus on the " language switch" and implications of switching from one language to another vs. engaging in one language alone. They tested response time and accuracy in naming pictures in three conditions blocked English (English only), blocked Spanish (Spanish only) and mixed (English-Spanish alternating names).

In all cases, English responses were more accurate (54-40) than Spanish responses. Similarly, the fastest times were in English (about 1010 milliseconds vs. 1148 milliseconds). The item of note was that when subjects were asked to alternate back and forth between English and Spanish (English, then Spanish, then English, etc) in predictable, alternating fashion, they performed the slowest, at 1276 milliseconds.

In all cases the left hemisphere was activated more than the right hemisphere and the dorsolateral prefrontal cortex (executive center-prefrontal lobe) was involved in switching back and forth between languages. It is believed that this "additional" process is what is responsible for slower response times. A study similar to this was conducted by Hernandez, Dapretto and Bookheimer which had findings consistent with this study.

Hernandez's finding reinforce the practical implications of Kohnert's work. The quicker English response times are evidence of better proficiency in L2 over L1 (in this case, Spanish). As was suggested earlier, English becomes the dominant language over time and is the language of the learner's academics. Spanish, used less and less frequently since the beginning of formal schooling in L2, does not receive the same academic emphasis and resultantly, proficiency declines. The slow response times in the combined condition, where the subject must alternate between L1 and L2, suggests that this is not a common activity. This makes sense, because the development of academic proficiency in L2 will extinguish the necessity to switch back and forth with L1. As early bilinguals, the subjects develop capacity in either language such that the added process of shifting no longer needs to take place within their L1 or L2 environments.

Finally, Hernandez and Kohnert teamed up to study the impact of age on the bilingual language switch effect. Sixty-four bilingual adults, half college-aged and half about seventy years of age were compared.

All participants learned their L2 prior to age eight and still reported using both languages daily. The younger adults were faster and more accurate in all conditions. Concomitantly, the reaction times and accuracy of responses of blocked conditions (all Spanish or All English) were fastest and most accurate compared to predictable alternating language prompts. The intriguing finding was that when the order of English and Spanish prompts was made unpredictable, accuracy and response times outperformed those which were predictable. The reasoning is this. Even though an alternating pattern is predictable, the brain MUST make the switch each time, accessing the executive center in the prefrontal cortex. In the unpredictable sequencing, two or more Spanish or English words may come in a row. In these cases, accessing the prefrontal region is not required, and the response time is less.

Where do these studies take us? Clearly, more research is needed to bridge the gap between controlled studies and classroom practice. Just the same, these studies are supportive of current best practices and begin to inform us-even beyond prior knowledge. The exploration for deeper

understanding beckons. With the help of such stellar researchers, we'll surely gain more insights soon.

Authors:
Robert K. Greenleaf, Ed.D.
Jeff W. Park, M.A.
LAB @ Brown University
800-521-9550 x310 or x240
greenleaflearning@cox.net
lto:Jeff_Park@Brown.edu Jeffrey_Park@Brown.edu

Submitted to:
Ben Ward, Editor

Bibliography

August, Diane, and Kenji Hakuta, eds., Improving Schooling for Language-Minority Children: A Research Agenda. National Academy Press, Washington, D.C., 1997.
Bruer, John. “Education and the Brain: A Bridge Too Far,” Educational Researcher, Vol. 26, (8) pp. 4-16, November 1997.
Cummins, Jim. Negotiating Identities: Education for Empowerment in a Diverse Society, California Association for Bilingual Education, Ontario, CA, 1996.
Eckman, Fred R., Diane Highland, Peter W. Lee, Jean Mileham, and Rita Rutkowski Weber, eds., Second Language Acquisition Theory and Pedagogy, Lawrence Erlbaum Associates, Publishers, Mahwah, NJ, 1995.
Greenleaf, Robert K. “Brain Based Teaching: Building Excitement for Learning” Self Published. greenleaflearning@cox.net or Greenleaf Learning, 34 Raymond Drive, Narragansett, RI 02882.
Greenleaf, Robert K. “Developing Language: The Science Behind Learning to Read” American Language Review, May/June 2000, p. 32-33.
Hernandez, Arturo, et. al. “ In Search of the Language Switch: An fMRI Study of Picture Naming In Spanish-English Bilinguals”Journal of Experimental Psychology: Learning, Memory & Cognition,v22,846-864.
Hernandez, Arturo E., et. al. “Processing across the Language Boundary: A Cross-modal Priming Study of Spanish-English Bilinguals,” http://www.psych.ucsb.edu/fac/hernande.htm.
Hernandez, Arturo & Bates, Elizabeth. “ Bilingualism and the Brain,” u/fac/hernande www.psych.ucsb.edu/fac/hernande.
Hernandez, Arturo & Kohnert, Katherine. “Aging and Language Switching in Bilinguals,”
Honig, Bill, “ Research-Based Reading Instruction: The Right Way.” The Education Digest, V.63, pp.15- 22, December, 1997.
Jensen, Eric. “Teaching with the Brain in Mind.” Yearbook. ASCD 1250 N. Pitt St. Alexandria, VA 22314, 1998.
Kim, Karl, Relkin, Kyoung-Min Lee, & Hirsch. “Distinct Cortical Areas Associated with Native and Second Languages.” Nature, V.388/10, July 1997.
Klein, D. et al. “ The Neural Substrates Underlying Word Generation: A Bilingual Functional-imaging Study,” Proceedings of the National Academy of Science USA. V.92, p.2899-2903.
Kohnert., et. al. “ Balancing Bilinguals: Lexical-Semantic Production and Cognitive Processing in Children Learning Spanish and English,” Journal of Speech, Language and Hearing Research, Dec. 1999.
Kohnert., Hernandez & Bates “Bilingual Performance on the Boston Naming Test: Preliminary Norms in English and Spanish,” Brain and Language