RECENT NEUROPHYSIOLOGICAL STUDIES OF THE BRAIN AND INTERHEMISPHERIC FOREIGN LANGUAGE LEARNING

Introductory remarks

With the help of the databases which we currently have at our disposal, especially on the Internet, I have examined the most recent studies on brain mechanisms with the question in mind as to how these studies could be relevant to foreign-language teaching.
For the last 20 years it has been possible to study brain functions with the help of modern equipment. This is done using non-invasive methods such as functional MRI (Magnetic Resonance Imaging) and PET (Positron Emission Tomography).

Let us first turn to some general remarks concerning the lateralization of the brain, i.e., the division of the brain in the left and in the right hemisphere.
In most humans the language area is located in the left hemisphere, whereas the right hemisphere controls emotions, melody and spatial perception. This holds true for 95% of people, insofar as they are right-handers, although surprisingly enough, this is equally true for the majority of left-handers, namely for 70% of them.

This means that, as far as language is concerned, it is not a natural phenomena for left-handers to have a right-hemispheric language area. Such inversely associated behaviours are typical of hearing because the right hemispheric hearing area is activated by what we hear through the left ear and vice versa. The limbs are also controlled in the same manner. However, for vision, this is only partially true since only one half of the field of vision in each eye behaves as such.

For the majority of humans the right, i.e., the non-language hemisphere develops a lot more than the left up to the third year after birth and it is only then that the left hemisphere begins to take over the language functions. If and when this process fails, speech disorders can manifest themselves in children.

In this respect humans have been particularly badly served by Mother Nature in their first year after birth, because we develop only 25% of our brain capacity, whereas monkeys, after barely one year, have already developed 70% of their brain capacity and a lot of other animals almost 100%. In the subsequent 4 to 5 years the human brain capacity is multiplied fourfold. And it is because of this rather slow process of growth that the human brain has much more time to adapt to the individual and complex conditions of its specific environment. In the first years after birth, for example, humans can learn not only their own native language, but various other languages as well, at least on an elementary communication level and on the condition that the languages are continuously being spoken in the child’s environment.

Further general findings of recent neurological research could be relevant for foreign-language teaching. As Schlaepfer (Schlaepfer 1995) concluded from his study, the language area in women is generally more distinctly developed than in men.

On the average Broca’s area is 20% larger in women than in men, Wernicke’s area is even closer to 30% (J. Havarty et al. 1997). This finding is consistent with the fact that women generally have better verbal skills than men. In foreign-language teaching at schools this parallel - at least after puberty - has been repeatedly pointed out during the last 50 years. (Carrol 1965, Carrol 1999)

Extrapolations from research concerning foreign-language acquisition

Let us now turn to research that can be relevant for foreign-language teaching. As far as the part of the brain involved in language is concerned, the Broca and the Wernicke areas are distinct. The former is especially responsible for the recognition of vocal sounds and their formation or articulation, whereas the latter, Wernicke's area, is the special location for the logical processing of language.

In their research Di Virgilio and Clarke (Di Virgilio, Clarke 1997) emphasize a research deficit, namely that the connectivity between Broca's and Wernicke's areas has not yet been fully clarified. Therefore their research has focussed on the elimination of this deficit. With the help of the PET-investigation they traced the connections on patients with an infarction of the inferior temporal cortex in the right hemisphere. They were able to determine direct inter-hemispheric connections between Broca's and Wernicke's areas and in this inferior temporal cortex. This speaks in favour of parallel pathways in visual-verbal processing. The patchy distribution of visual inter-hemispheric connections within Wernicke's area hints at a functional compartmentalisation of this area. Such a link is extremely interesting for foreign-language teaching.

It is supported by further research. In 1998 Collins and Coney were led to conclude that both abstract and non-abstract words are anchored in a complex network in the left hemisphere, but that concrete words, which produce a visual association, are processed simultaneously in a "subsidiary word processor". In other words they produce an inter-hemispheric communication. In a later study Zencius et al. (Zencius et al. 1997) reported that brain-injured patients learned better when what they heard was simultaneously being presented on flashcards and when the exercise was subsequently repeated in a peer group by means of question and answer.

The correlation between various senses to improve memory has a long tradition in foreign-language teaching, which does not exclusively originate with the *Orbis sensualium Pictus* of Comenius, but which has its sources with the Greek and Roman rhetoricians, especially Quintilian. The mnemotechniques do not have their origin in the use of pictures, but rather in the visual representation of *loca* familiar to the orators.

A return to the use of these mental images in foreign-language teaching has only recently been introduced by Holtwisch (Holtwisch 1992).

On the other hand, for a long time it has been concluded again and again that multi-sensory, respectively polymodal learning leads to higher memory performances. According to the consolidation hypothesis (Sinz 1978), using polymodal encoding through various senses via a subsequent consolidation phase can decrease the amnesia-gradient and increase the consolidation-gradient.

Similarly, Paivio (Paivio 1979) has attributed his successes with memory increase to the activation of the left hemisphere of the subjects by the words which had to be learned by heart and of the right hemisphere by the simultaneous visual representation of the word concept.

Apparently the quoted neurological insights into the brain functions confirm the 20-year-old psychological knowledge and the 2000-year-old mnemonics.

It should be pointed out, however, that the current overflow of visual stimuli, as found in modern textbooks, is by no means the right methodological conclusion to be drawn from this research. The visual overflow of information may lead to weakened perception.

An active visualization method of learning, like, for example, the use of visual mental representations when storing foreign-language data, is possibly more effective than a lot of pictures. This way the pupils are being stimulated to mentally represent verbally expressed processes, such as they occur in textbooks, in order to remember them better.

The active linking between written foreign-language items and pictures to form word-icons goes much along the same lines: for example, the teacher writes the word *pollution* in such a way that the double l represents two funnels producing dark smoke.

Research concerning the language-area of the brain in the deaf

Extrapolation of the studies of deaf people may well open up new vistas for foreign-language teaching. The PET-experiments by McGuire et al. (McGuire et al. 1997) prove that the profoundly deaf, when they use ”inner signing” of sentences, are not using the visuo-spatial areas of the right hemisphere which controls visual and spatial perception, but rather they use the brain area which in hearing people belongs to the language area, and gets activated when they practice inner speech.

These findings are of particular interest to the foreign-language teacher. They allow one to draw the conclusion that in all probability, for deaf and hearing pupils, gestures accompanying language used in foreign-language learning further activate that part of the brain which is responsible for acquiring linguistics skills.

Research on the use of gestures in foreign-language teaching

Three studies have revealed clues in this respect. Student groups who were completing beginners’ courses in French, were given a literary text with 534 unfamiliar words. (Schiffler 1988). The first group learned the text and the German translation by means of ”suggestopedia”; i.e., the bilingual text was first read by the teacher to the accompaniment of classical music, then the contextual and bilingual vocabulary was repeated during a relaxation phase with barock music. On the average these students could translate 222,9 words (48,2%). The second group learned as they pleased, either on their own or in pairs or groups. They could correctly translate 225,8 (50,4%) words into German. The third group, however, learned in an accelerating rhythm suggestopedically and additionally with gestures, what I call ”body learning”. They could correctly produce 270,5 (82,9%) of the translations. This clear difference was, however, only significant with the marginal error of 10% and could, as a consequence, only be interpreted as an indication of a possibly correct method.

This last experiment with ”body-learning” was repeated in five German classes who learned French as a third language. We also added a phase where the students tested one another on vocabulary (of the text). On average, they learned more than 60 words during the experimental lesson of one hour (Schiffler 1992).

More conclusive on the other hand is the study by Pillar (Pillar 1996). Four groups were taught foreign languages. The first group heard all the dialogues on cassette, as did the second group, which also received drama lessons, however. The third group learned through videos and through additional teaching in drama, whereas the fourth group learned with the video-samples only.

The third group, which learned through video and with additional teaching in drama, surpassed the other three groups significantly in all end-results.

Other research seems to support these methodological suggestions. Mayberry (Mayberry 1996) concluded from his PET-study that neurologically healthy people activate the right hemisphere regions during an emotional prosody recognition, especially when they respond to it. Why shouldn't our students use more emotional prosody during loud learning and repeating new words or sentences? Why shouldn't they combine "body-learning" with speaking aloud and emotional intonation?

Research concerning language and relaxation

An experiment by Jasiukaitis et al. (Jasiukaitis et al. 1997), related to language and relaxation, was quite surprising even for the brain researchers, because over the previous decades it had generally been accepted that during hypnosis the left hemisphere, the seat of language in most people, becomes completely inactive because of the use of language, whereas the right hemisphere, which among other things is more responsible for emotional and spatial processes, becomes the focus of brain activity. The aforementioned investigators found the exact opposite: As a result of the use of language and the concentrated and focussed attention involved, some hypnotic phenomena could be appropriately seen as belonging to the left-hemispheric brain functions.

We have already mentioned the procedure called "suggestopedia", which aims at a more effective method of learning a foreign language by rehearsing the new data in a relaxed situation. This way they can be remembered and stored in long-term memory more easily. This is not a question of hypnosis, which presumes a state of deep relaxation, but of the so-called Alpha-state, which refers to a pleasant, relaxed state manifesting itself in the brain by an intensified occurrence of the Alpha waves. It can be induced by music but also reached by the appropriate words. Since neuropsychological research has determined that the language area is active even in a state of deep relaxation, it is certainly safe to accept that this is the case in a state of light relaxation and that foreign-language learning data can be processed in this way.

The long-term experiments with four groups (Schiffler 1992) have shown that teaching which systematically rehearses learning data by means of music-induced relaxation, is more effective, provided that the teaching is intensive and takes up to four hours a day. This has also been confirmed by intensive teaching of 14-year-old pupils. Further long-term research (Holtwisch 1990) during half a year in regular school teaching has demonstrated an improvement in the general performance of the whole class, as compared with a parallel class, and, furthermore, an increase in the self-assurance and a decrease in the anxiety-level of the pupils.

Conclusion

On the basis of the present research findings, no single method should be favoured, but the more frequent use of the following methods should be encouraged:

- a different kind of active mental visualization by the learner
- gestures combined with loud learning of vocabulary ("body-learning"), emphasizing emotional intonation and rhythm
- role-playing of sketches and
- learning data by combining relaxation with memorizing techniques

Carrol, J. B. (1965). Research on Teaching Foreign Languages. In *Handbook of Research on Teaching*, Gage, N.L.(ed.). Chicago, 1060 - 1100

Clark, R. (1972). *Hemispheric asymmetry: Prosodic and syntactic factors*. Master's Thesis, Sir George Williams University.

Collins, M. and Coney, J. (eds.) (1998). Interhemispheric communication is via direct connections. In *Brain and Language* 64 (1), 28-52.

Di Virgilio, G. and Clarke, S. (eds.) (1997). Direct interhemispheric visual input to human speech areas. In *Human Brain Mapping* 5 (5), 347-354.

Gazzaniga, M. S.; Eliassen, J. C.; Nisenson, L.; Wessinger, C. M.; Fendrich, R.; Baynes, K. (eds.) (1996). Collaboration between the hemispheres of a callosotomy patient: Emerging right hemisphere speech and the left hemisphere interpreter. In *Brain* 119 (4), 1255-1262.

Havasty, J., Double, K. L., Halliday, G. M., Krill, J. J., McRichie, D. A. (eds.) (1997). Language-associated cortical regions are proportionally larger in female brain. In *Archives of Neurology* 54 (2), 171 -176.

Holtwisch, H. (1990). Fremdsprachen alternativ! - Untersuchungen zur Wirksamkeit der suggestopädischen Methode im schulischen Englischunterricht. Bochum: AKS-Verlag.

Holtwisch, H. (1992). 'Mindmapping' im Fremdsprachenunterricht. Ein Beispiel für hirngerechte Textverarbeitung. In *Praxis des neusprachlichen Unterrichts* (1), 38 - 43.

Jasiukaitis, P.; Nouriani, B.; Hugdahl, K.; Spiegel, D. (eds.) (1997). Relateralizing hypnosis: Or, have we been barking up the wrong hemisphere?. In *International Journal of Clinical and Experimental Hypnosis* 45 (2), 158-177.

Kimura, O.(1964). Left-right differences in the perception of melodies. In *Quarterly Journal of Psychology* 15, 166-171.

Mayberry, R. I. (1996). First-language acquisition after childhood differs from second-language acquisition: The case of American Sign Language. In *Journal of Speech and Hearing Research* 36 (6), 1258 - 1270

McGuire, P. K.; Robertson, D.; Thacker, A.; David, A. S.; Kitson, N.; Frackowiak, R. S. J.; Frith, C. D. (eds.) (1997). Neural correlates of thinking in sign language. In *Neuroreport* 8 (3), 695-698.

Paivio, A. (1979). Effects of an imagery mnemonic on second language recall and comprehension. In *Canadian Journal of Psychology* (1), 17-27.

Pillar, G. (1996). *Towards a synerlinguistic approach to language learning: Investigating the utility of video-mediated paralinguistic behaviour in developing communicative competence*. Doctoral Thesis, University of Newcastle NSW, Australia.

Quintilian, M. F.. *De institutione oratoria*. XI, 18 - 19

Schiffler, L. (1988). Suggestopédie - Peut-on apprendre 500 mots en 3 ou 4 heures?. In *Le Français dans le Monde* (217), 63 - 36.

Schiffler, L. (1992). *Suggestopedic Methods and Applications*. New York: Gordon & Breach Science Publisher.

Schiffler, L. (1990). Abschluß der vierjährigen Langzeituntersuchungen zum suggesto-pädischen Fremdsprachenunterricht - Kurzzeituntersuchung zum Behalten der Bedeutung von 1000 Vokabeln. In *brennpunkt Lehrerbildung* FU Berlin (10), 17 - 19.

Sinz, R. (1978). *Gehirn und Gedächtnis*. Stuttgart - New York.

Schlaepfer, T. E.; Harris, G. J.; Tien, A. Y.; Peng, L.; Lee, S.; Pearlson, G. D. (eds.) (1995). Structural differences in the cerebral cortex of healthy female and male subjects: A magnetic resonance imaging study. In *Psychiatry Research* 61 (3), 129-135.

Zencius, A. H.; Wesolowski, M. D.; Rodriguez, I. M. (eds.) (1998). Improving orientation in head injured adults by repeated practice, multi-sensory input and peer participation. In *Brain injury* 12 (1), 53-61.