

**Title: Decoding behaviour and connectivity mental system in second language context: critical period and the lateralization of language function.**

*Sandra Andrade de Bastos Figueiredo<sup>1</sup>  
Carlos Fernandes da Silva<sup>2</sup>*

*PhD student of the University of Aveiro, Educational Sciences Department, Portugal<sup>1</sup>  
Full Professor of University of Aveiro, Educational Sciences Department, Portugal<sup>2</sup>*

**Abstract:**

The factors that distinguish individuals in the second language (L2) acquisition process are age, gender, the neuronal and cognitive maturation, previous linguistic knowledge and the psychological and affective aspects. The environment influence must not be understood as another isolated factor, but as the determinant background that implies all the factors considered. The aim of our general research project, on the basis of two empirical studies, is to present the process of L2 acquisition in a holistic style, considering the cognitive and affective perspectives. The research that has been developed in the language acquisition area disclosed some results, which allow perceiving that several psychological, biological, and neuropsychological factors are involved actively in the predisposition of the individual with migratory experience for his/her psychosocial and academic growth. **Method:** Regarding the lack subsisting in the second language acquisition research, it was developed a assessment instrument to observe the different verbal behaviour of 130 students (7-30 years old), with monolingual and second language learning profiles, at several cognitive and linguistic levels, considering age, gender and also all the migratory experience profiles. **Results and Conclusions:** Findings in what concerns the decoding competence will be discussed, regarding phonological awareness, memory, auditory and visual discrimination. The results of the dichotic hearing test (in the second language learners sample) will be here discussed, applying to the critical period of discriminating behaviour. We suggest a hypothesis of a mental linguistic system of connectivity (of functions) that could be stabilized/fossilized in the younger learners, that, in addition to the abilities of abstractness yet not full developed, result in a linguistic achievement decrease.

**Key Words:** second-language acquisition, critical periods, cognitive behaviour, dichotic hearing.

## **I. Theories and perspective analysis toward verbal behaviour: plasticity and the decoding skills status.**

In the literature, frequently, the concept of 'environment', which we must apply as 'context', is considered as a different factor when we consider the other variables such age, gender and cognitive profile. The context (the social, political and linguistic background) must be understood as a set of all the events. Here the 'event' is the concept from the radical behaviourism (Skinner, 1978) to describe things that occur in the internal environment - mind and body - and externally (example of economic and educative condition/status), that are influencing the behaviour. The factors that previously are described as determinative factors to the verbal behaviour are in that concept of 'context'. The first factors mentioned above are (age, gender, cognition, linguistic knowledge), for some authors, the most implied in the explanation of the differences between the several learning-subjects. Nevertheless, other authors consider the affective filtering factor as the main one.

The fundamental criterion that divides the authors states on the adoption of two important theoretical frameworks: the structuralism (mentalism) and the behaviourism (functionalism). The genesis of the language repertoire is always explained in the light of these two poles.

The notion of 'inatism' (structuralism) can not be argued as exclusive explanation in the language development, applied to the first and second language contexts. The 'language acquisition device' (Chomsky, 1957) is the human mechanism to guarantee the language development, considering the linguistic input as a secondary influence. This ability is developed as a mental structure (where private events occur that are difficult to the direct observation), which in turn, however, is the result of the stimulus operated by the 'context'. The verbal behaviour depends on the relation of various factors and among them we find the mental structures, which along with other events, help to form the set of stimuli: the context. In the first acquisition of language context, the biological factors (mind) are involved effectively, but not constituting key factor in the acquisition of second language. This means that the elements (gender, age, culture, first language, formal education, verbal community) that constitute what we call the 'context' and are essentially external (not depending exclusively from the internal structures of the human mind) will act with greater emphasis in the development process of L2. Thus, the maternal language is acquired in a separate acquisition of the second language, when occurring in different ages, not simultaneously, regarding the greater or lesser influence that several factors take the course of life.

The Generative Grammar Theory of Chomsky (1957) fits in the principle of genetic determination (or inateness) which implies the basic principles governing the organization in the brain: programs and neural mechanisms of representation and processing. But this 'gene' determination constitutes a further element of the environment (the 'context') of the individual, which influences the general and the verbal behaviour, and this one influences that

context: the dynamic perspective of behaviour analysis. This assumption, considering aspects from both theories, could engage a consistent research that analyse and explain the differences in the verbal behaviour of children and adults: second language learners.

When L2 acquisition<sup>1</sup> occurs in an early age, it is more likely that the subject acquires native - like linguistic competence. Nevertheless, adults have the advantage in some general learning skills - formal and abstract abilities in problem solving - of the L2. They also have greater capacity of transference, where the children do not yet have this mastery; however, the adults have greater failure in the pronunciation and fluency, skills that demand expert auditory resources. The child does a selective echo toward mother tongue and the inevitable failures, resulting from logical operations, are 'symptoms of the natural crisis of growth'. The age factor always is considered above other factors, by most research, evidencing the children as the true acquirers experts in the acquisition of L2, condemning the adults to the failure (Ritchie & Bhatia, 1996). In fact, age is just one of the criteria that must be advised in this theme, regarding that other factors (culture, nationality, first language, gender, socioeconomic condition) are concurring with 'age' to the language learning success. The mastery of the youngest learners is increasingly becoming a controversy (Lenneberg, 1967; Johnson & Newport, 1991).

One of the explanations, from the neuropsychological field, is the involvement of the right hemisphere that becomes deeper with age advance in the L2 processing, while the acquisition of the "natural language style" (Krashen, 1989) appeals to the typical operations in the left hemisphere. This question of the hemispheres is still controversial, but it is certain that older individuals show greater involvement of the right hemisphere (Lenneberg, 1967). We can apply this finding to the fact that dichotic hearing ability changes from the right ear to the left ear advantage with age. The inter-hemispheric action (that provides the changes on the auditory discrimination) allows for a specialization of different areas of the brain in specific functions. The neurosensorial capacity has not been lost, only the strategies of processing have been modified at this level (Werker & Tees, 1984; Krashen, 1989). According to Krashen, from five years old onwards language learning becomes a more rigid process, therefore entering in the formal domain, once the sensitive period has finished. However, authors (e.g., Lenneberg 1967; Newport 2002; Johnson & Newport, 1991; Long 1990; Scovel 1988; Seliger 1978) proposed that it will be from puberty onwards (12/13 years old) that the critical period for language learning (readiness) has its decline. Other authors, such as Johnson and Newport (Johnson & Newport, 1991) situate the end of this period around seven years of age, considering that until there the second language can be learned to a level that is grammatically indistinguishable from

---

<sup>1</sup> Acquisition is conceptually different from Learning, applied to the language development field. Acquisition refers to the 'natural' assimilation of knowledge, based on the exposition and conditioned, by the verbal communities (Skinner, 1957). The acquisition mode is related to the critical period hypothesis, the period which is the most favourable to the languages acquisition, present since birth until puberty (Lenneberg, 1967). Learning is not natural assimilation and is based on instruction; Learning is mostly considered as more difficult than acquisition regarding that is required the formal conditions to access knowledge (the example of alphabetization at the level of write and read competences development).

that of the native speaker. However, around eight to ten years old it becomes difficult to completely master the grammar. This does not mean that the adult person will not be able to learn the grammar of a foreign or second language. However the adult will not make it in acquisition circumstances.<sup>1</sup> At the semantic level, however, there is not a sensitive period for its acquisition (Neville & Bavelier, 1998; Stowe & Sabourin, 2005; Uylings, 2006), it is a process that can be developed in any age: “*Critical period effects thus appear to focus on the formal properties of language (phonology, morphology, and syntax) and not the processing of meaning*” (Newport, 2002, p. 738).

It is expected that the listening decoding, including the specifically dichotic hearing context, would be easier in the early ages. This is due to the fact that the use of more than one language implies that the individual becomes more careful in the information selection when processing it (*in* Gullberg & Indefrey, 2006). The individuals become prepared for inhibition strategies and develop control mechanisms that help to balance the self-linguistic system and to conciliate memory processes in both languages (Levy et al., 2007). On the other hand, children need more acoustic information (inputs) to produce a successful output, and the dichotic stimuli could compromise this need. The children pay more attention to the phonetic details (selective attention), but do not reach such accuracy for the sounds that are less significant to segment comprehension (Best, 1999). The listening comprehension could be also threatened by the fact that adults tend, when possible, to filter the non-familiar sounds in the phonologic system of their First Language (transference) (Best, McRoberts, Sithole, cited by Vihman, 1996; Gillon, 2004). Older people tend to rationalize (awareness) more the discrimination process and present more dysfunctions in the perception of non-familiar sounds and in their blending. In the dichotic hearing field, it is known that the right ear advantage is replaced in the first years of life, becoming the left ear advantage but the individual shows less correct answers in the decoding. The second language learning seems to accelerate the inter-hemispheric action and favours the listening comprehension in general, mainly the discrimination skill (Chuanren, 1992). However, there are data that conclude that bilingual males (Persinger, 2002) commit higher decoding failures with the left ear input, comparatively to the monolinguals (male and female), and bilingual females present more mistakes both in the left and right ear inputs registering. The verbal memory is lower in males who acquire the second language after the five years of age, in spite of exhibiting a positive memory to the figural mode of the speech information. In the auditory processing, the right hemisphere is activated for the global pattern recognizing and the left hemisphere functions in the stimuli sequences organization and to identify the inputs listened to (Onoda, Pereira & Guilherme, 2006). It is curious that the dyslexic population did not show right ear advantage, even in the early years of age (Sauer, 2006), because there is difficulty with the short-term memory (as a sequential memory that achieves the phonemic organisation) to block the competitive sounds, which is important to the reading skills. In a dichotic hearing test the individual can present a global (binaural/divided attention) or partial (binaural separation/focalised attention) answers. In the second language context attainment on the dichotic hearing performance is verified at a level of auditory

processing disorder (Cameron, Barker & Newall, 2003). The tests used in the dichotic hearing assessment are the Dichotic Digit test, consonant-vowel dichotic listening test, sentences identification dichotic hearing test and the Wilcoxon-Mann-Witney test (Munhoz, Quintero & Marone, 2002). In the second language research field these tests are not currently applied to assess the second language and decoding skills effects.

1

## II. METHOD

### *Participants*

The sample regards, in the first phase of the study, 64 second language learners, different language speakers, and with different nationalities, who arrived in Portugal not more than four years ago (most arrived during 2006). The sample was selected in order to integrate three age groups - children (7-12 years), adolescents (13-17 years) and adults (18-30 years). Within each of these groups there are sub-groups (7-9; 10-12; 13-15; 16-18; 19-23; 24-30; or 7-12; 13-18; 19-30). The individuals are students of Basic Education (all the cycles), High School and Higher Education, from several schools of the district of Aveiro, Portugal.

### *Instruments*

A battery of tests was developed, in electronic support, and the programming work was carried out between October 2006 and January 2007. The format of the test allows the effectiveness and organization of the data and task structure, as well as the control of the time spent on each task for each individual. The aim of this battery was to analyse the phonological awareness of second language learners (who have the Portuguese as second language) with several tests<sup>2</sup>.

---

<sup>2</sup> These tests range from dichotic hearing, perception of rhyme, onset and rime, alliteration and syllable, conditioned grapheme writing, alphabetical ordinance, phonemic and lexical segmentation, detection of minimum pairs, spelling, phoneme blending, words counting, syntactical awareness, reading and auto-evaluation, and foreign phonetic perception in L2.

This battery presents good internal consistency with alpha of Cronbach of .75 (N of items=54), having been excluded the factor “Duration 13” that compromised the consistency.

### *Procedures*

The application of the battery of tests was done individually, taking each application 35 to 100 minutes, at the school of the subject, who must fulfil the test in a computer. For the application of the test, it was necessary, besides the computer, headphones and microphone. All procedures were previously carried out to get the necessary authorizations from the schools, teachers and tutors of the students. In January 2007, the battery was applied to native children (cognitive debriefing study) in order to proceed to the correction and confirmation of the test’s functionality.

### **Results**

Regarding the subjects distribution in the statistical relation between “Age” and “Identification\_Left Ear (LE)” variables (test 8- identification of words in sequence), we find a non-random distribution ( $\chi^2=14,666$ ;g.l.\_6;p\_.023;  $\eta=.368$ ). The group II (13-18 years old) presents more positive answers regarding the left ear input, followed by the group III (19- 30 years old) with 14 participants reporting 1 segment (word). The Group I (7-12 years old – 60%) is the group with less identification in this test. Look at the table n.º 1.

[Insert table here]

In what concerns the subjects distribution between the “Age” and “Conversion” variables (test 8 - detection of nonwords converted to words – with phonological but not semantic similarity), we find that the distribution is not accidental ( $\chi^2=34,629$ ;g.l.\_20;p\_.022;  $\eta=.387$ ). The group IV (16-18 years old) shows more operations (4 nonwords converted – 100%), followed by the group V (19-23 years old) with 3 nonwords converted (100%). The Group III (13-15 years old) had the lower performance in this activity (7 of 15 subjects do not converted nonwords). Look at the table n.º 2.

[Insert table here]

Regarding the distribution of the sample according to the variables “Age” and “Reports” (test 9), we find a consistent distribution ( $\chi^2=30,817$ ;g.l.\_20;p\_.05;  $\eta=.238$ ). Among the age categories, the group III (13-15 years old) shows higher number of reports (5 words – 100%; 4 words

– 28,6%), followed by the group V (19-23 years old-50%) with 4 words reported (42,9%). The other groups, I (7-9 years old), II (10 – 12), IV (16-18) and VI (19-30), present the minimum achievement at this level.

## Discussion

The classic assumption that children are privileged by their selective attention (Bialystok, 2006), favoured by an ‘emotional latency’ (Figueiredo & Silva, 2006) and by the language mastery at the phoneme (phones) discrimination, becomes controversial with our study and with previous framework (Hollingsworth, 1983). Adults could be experts in the second language learning, even more successfully than children, because the child’s native-like competence is surpassed by the velocity (Ritchie & Bhatia, 1996) that adults reach in the L2 syntactical and morphological sensitivity. The dichotic hearing is a technique for lateralization assessment and is reported as test of the battery, developed as instrument of this research. The dichotic hearing task (test 8 of the battery) presents eight words, 4 for each input (left and right ears). Considering the importance of this type of measure and its role on the language lateralization, related with the acquisition of L2, and taking into account that there are very few of these studies in the second language field, and none are known in Portuguese research, we intend to contribute with our study to know more about the implied neuropsychological factors in the language processing, more specifically in the context of L2. There is scientific evidence that the right ear advantage, in speech understanding, is changeable with the age advance and decline, as happens with the attention, processing rhythm, working and declarative memory, skills designed for several L2 development stages (Hugdahl, Carlsson & Eichele, 2001). In our dichotic hearing test, in each set of the 4 words, we put 2 words and 2 nonwords (*pseudowords*) in Portuguese. Some sounds sequences presented as input for the left ear were stronger for the hearing, but not with higher acoustic signal, to balance the natural (tendency of the right ear advantage) ability of the two ears. The individual could hear the inputs and answer during or after listening, according to the personal reaction. We found significant differences between the age groups at some levels of this test. The older individuals detect more stimuli in what concerns the left input. The children are the participants with more failures in the reception and discrimination of this input (left). It is already possible to verify that the oldest students catch in an easier way the sequence presented as input to the left ear. It was expected that the input shown to the right ear would be more reported by the children, but in fact this actually does not happen.

The speech sounds are, in normative conditions, decoded more easily when entering the right ear due to the direct *linking* between the sound-stimuli received and the left hemisphere, where exists the areas that are predominant for the language and its processing. Here the context does not contribute to this general assumption. It is an evidence that the more delayed

the learning (not acquisition) of L2, the more involvement the left ear has and, thus, the greater is the risk in the message decoding. On the other hand, as the L2 learners get older (Lenneberg, 1967) the implication on the right hemisphere, in respect of discriminations to carry through L2, seems bigger. The right ear dominance is replaced by the inter-hemispheric processing, which is accelerated by the L2 acquisition in an advantageous way (Chuanren, 1992). In fact, the latter is the acquisition of L2, the more activation will occur in the right hemisphere at the processing level. Applying to studies with monolingual samples, and considering always a normative sample, it is verified that the discrimination ability of the two ears increases for both, but with more evidence for the left (Pohl, 1984; Nagai, 1997). We know, however, that properties of the speech such as the prosodic aspects have direct relation with the right hemisphere areas, and prosodic is one of the main aspects of the message decoding (Jancke, 1994). Taking the above into account, we can state that the sequences with stronger prosodic characteristics are the most detected, but with bigger incidence for the left ear, which can be explained by the greatest intervention of the cerebral right hemisphere (specific areas) to interpret the properties of phonemic sequences. Our hypothesis is that the 'dysfunction', which results of the lateralization, would increase with age (age of acquisition, Stevens, 2006). However, in our research, at the moment, the categories of the dichotic hearing (total and partial identification, assimilation, word and nonword transformation) are particularly related with the right ear input and there is no significant difference between the individuals. The adolescents detect stimuli presented and processed by the both sides (left and right ears). Our results could direct to other perspective: this inter-hemispheric activation could be attained early in second language acquirers, which gives a distinct cognitive profile when compared to the monolinguals. Nevertheless, the question remains: could this early change in the hemispheric action be positive or negative for the general cognitive processing and, particularly, to the phonemic decoding?

It is also visible that the adults and adolescents catch greater number of words, while children register fewer words but present less mistakes, which discloses that they are more selective in the decoding of sounds. In fact, children did not also present higher achievement at the conversion of nonwords to words, which can contribute to explain that the children select more accurately the signals heard. On the other hand, it is believed that the children have greater acceptability/receptivity toward nonwords, than the older subjects. Bilingual or L2 learners become more flexible in what concerns the acceptance of sequences that are phonologically perceived but meaningless (pseudowords), because they easily apprehend the conventional relations in language (Baker 1997). However, in this study children did not reveal differences from other participants at the nonwords report.

## Conclusion

As a general conclusion, regarding the previous data, we are presenting a contribution in the second language development area. In Portugal, there is no knowledge of research developed in the dichotic hearing field applied to the assessment of age effects in second language processing. Regarding the results we may suggest that for the second language skills development there is a mental system (connectivity of functions) which structures could be fossilized even in the youngest learners, after the puberty (age classically determined for the decline of the critical period). The fossilization is a pathological condition in the first language context, but in the second language context is the crystallization of structures that compromise the process and processing, not verifiable, however, in the lexical and semantic development. That fossilization (or stabilization) is blocked by the influence of, not only, internal structures, but also external factors such as the different types of languages (mother tongue of the individual).

In the other hand, is necessary to understand the relevance of the verbal abilities, specifically in the second language context, as conditioning the general human behaviour, promoting the cognitive flexibility and the reversibility capacity.

## References

- Baker, Colin. (1997). *Foundations of bilingual education and bilingualism*. Clevedon: Multilingual Matters Ltd.
- Best, C. (1999). Native-language phonetic and phonological constraints on perception of non-native speech contrasts. *Acoustical Society of America Journal*, 105 (2):1034.
- Bialystok, E. (2006). Second-language acquisition and bilingualism at an early age and the impact on early cognitive development. *Encyclopedia on Early Childhood Development*. Available at [www.excellenceearlychildhood.ca/documents/BialystokANGxp.pdf](http://www.excellenceearlychildhood.ca/documents/BialystokANGxp.pdf) [8, January, 2007].
- Bishop, D., Mogford, K. (2002). *Language development in exceptional circumstances*. Rio de Janeiro: Revinter. [In Portuguese].
- Cameron, S., Barker, R. & Newall, P. (2003). The effect of linguistic background on the Macquarie Pediatric Speech Intelligibility Test. *Australian and New Zealand Journal of Audiology*, 25 (2): 95-98.
- Chomsky, N. (1957). *Syntactic Structures*. The Hague/Paris: Mouton
- Chuanren Ke (1992). Dichotic listening with Chinese and English tasks. *Journal of Psycholinguistic Research*, 21: 463-471

- Figueiredo, S., & Silva, C. (2006). Creation of an external assessorship as an emergent resolution toward the educative needs of immigrant students. *EDUCARE/EDUCERE Journal*, 19: 53-68. [In Portuguese].
- Gillon, G. T. (2004). *Phonological Awareness: from the research to practice*. NY: Guilford Press
- Gullberg M., & Indefrey, P. (2006). *The cognitive Neuroscience of Second Language Acquisition*. Oxford: Blackwell Publishing, Ltd.
- Hollingsworth, Sandra. (1983). Decoding Acquisition: a study of first grade readers. Available at [http://eric.ed.gov/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?\\_nfpb=true&\\_ERICExtSearch\\_SearchValue\\_0=ED240504&ERICExtSearch\\_SearchType\\_0=eric\\_accno&accno=ED240504](http://eric.ed.gov/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?_nfpb=true&_ERICExtSearch_SearchValue_0=ED240504&ERICExtSearch_SearchType_0=eric_accno&accno=ED240504) [9 January 2007].
- Hugdahl, K., Carlsson, G., & Eichele, T.. (2001). Age effects in dichotic listening to consonant-vowel syllables: interactions with attention. *Developmental Neuropsychology*, 20 (1): 445-457.
- Jancke L. (January – February 1994). Hemispheric priming affects right-ear advantage in dichotic listening. *The International Journal of Neuroscience*, 74, 1-4: 71-7.
- Johnson J. S., & Newport E. L. (1991). Critical periods effects on universal properties of language: the status of subadjacency in the acquisition of a second language. *Cognition*, 39: 215-58.
- Krashen, Stephen D. (1989). *Language acquisition and language education*. New York: Prentice Hall.
- Krashen, S. D., Sarcella R., & Long, M. (eds.) (1982). *Child- Adult Differences in Second Language Acquisition*. Rowley: MA: Newbury House.
- Lenneberg, E.H. (1967) *Biological Foundations of language*. New York: John Wiley.
- Long, M.H. (1990). Maturation constraints on language development. *Studies in second language acquisition*, 12: 251-285.
- Levy, J. B. McVeigh, N.D., Marful, A., & Anderson, M.C. (2007). Inhibiting your native language: the role of retrieval-induced forgetting during second-language acquisition. *Psychological Science*, 18 (1): 29.
- Munhoz, R., Quintero, S. & Marone S. (2002, March/April). Assessment of auditory processing by SSW test applied to individuals with normal hearing and absence of contralateral acoustic reflex. *Otorrinolaringology Brazilian Journal*, 68 (2).
- NAGAI, Katsumi (1997). A concept of critical period for language acquisition. Its implication for adult language learning. *Bulletin of the Society for the Study of English Education*, 32: 39-56. Osaka: Society of English Education.
- Neville, H.J. (1998). Neural organization and plasticity of language. *Current Opinions in Neurobiology*, 8: 485-496.

- Newport, E.L. Critical Periods in Language Development. (2002). In L.Nadel (Ed.), *Encyclopedia of Cognitive Science*. London: Macmillan Publishers Ltd/Nature Publishing Group.
- Onoda, R., Pereira, L., Guilherme, A. (November/December, 2006). Reconhecimento de padrão temporal e escuta dicótica em descendentes de japoneses, falantes e não-falantes da língua japonesa. *Otorrinolaringology Brazilian Journal*, 72 (6): 737-746. [In Portuguese].
- Persinger, M., Chellew- Belanger, G. & Tiller, S. (2002). Bilingual men but not women display less left ear but not right ear accuracy during dichotic listening compared to monolinguals. *International Journal of Neuroscience*, 112 (1): 55-63(9).
- Pohl, P.(1984). Developmental changes in dichotic right ear advantage (REA). *Neuropediatrics*, 15 (3):139-44.
- Rimol L. M. et alii. (2006). The effect of voice-onset-time on dichotic listening with consonant-vowel syllables. *Neuropsychologia*, 44 (2):191-6.
- Ritchie, W.C., & Bhatia, T.K. (1996). Second language acquisition: Introduction, foundations, and overview. In W.C. Ritchie & T.K. Bhatia (Eds.), *Handbook of Second Language Acquisition*, 1-46. San Diego, CA: Academic Press.
- Sauer, L. Pereira, L., Ciasca, S., Pestun, M. & Guerreiro, M. (2006). Dichotic listening and spect in dyslexic children. Results from Archives of Neuro - Psychiatry, 64 (1). Available at [www.scielo.br/scielo.php?pid=s0004-282x2006000100022&script=sci\\_arttext](http://www.scielo.br/scielo.php?pid=s0004-282x2006000100022&script=sci_arttext) [12 July 2007]. [In Portuguese].
- Scovel, T. (1988). A time to speak : psycholinguistic inquiry into the critical period for human speech. Rowley, MA: Newbury House.
- Seliger, H. W. (1978). Implications of a multiple critical periods hypothesis for second language learning. In W. Ritchie (Ed.), *Second Language Acquisition Research: Issues and implications*, 11-19. New York: Academic Press.
- Sim-Sim Inês (1999). Desenvolvimento da Linguagem [Language Development]. Lisboa: Universidade Aberta.
- Skinner, B.F. (1978) The Verbal Behavior as a Dependent Variable. In: The Verbal Behavior, 29-52. (Trans. De Maria da Penha Villalobos). São Paulo:Cultrix Editor. [In Portuguese]
- Snow, C. E., Bursn, S. M., & Griffin, P. (Eds) (1998). Preventing reading difficulties in young children. Washington: National Academy Press.
- Stevens, G. (2006). The Age-Length-Onset Problem in Research on Second Language Acquisition Among Immigrants. *Language Learning* 56(4): 671-692. Language Learning Research Club, University of Michigan.
- Stowe, L. A. & Sabourin, L. (2005). Imaging the processing of a second language: effects of maturation and proficiency on the neural processes involved. *International Review of Applied Linguistics in Language Teaching*, 43:329-535.
- Uylings, H.B.M. (2006). Development of the human cortex and the concept of “critical” or “sensitive” periods. In Gullberg & Indefrey (Eds.), *The cognitive neuroscience of second language acquisition*. Oxford: Blackwell Publishing, Ltd.
- Vihman, M.M. (1996). *Phonological development: the origins of language in the child*. Cambridge: Blackwell.

Werker, J.F., & Tees, R.C. (1984). Phonemic and phonetic factors in adult cross-language speech perception. *Acoustical Society of America Journal*, 75 (6):1866-78.

## Tables

**Table 1** Achievement of second language learners (determined by age) in the dichotic hearing test: identification of left ear input.

		Dichotic Hearing Test – Identification of LE input (n° of reports)				Total	
		0	1	2	3		
<b>Age groups</b>	7-12	N	12	6	1	0	19
		% within age groups	63,2%	31,6%	5,3%	,0%	100,0%
		% within LE input	<b>60,0%</b>	18,2%	16,7%	,0%	31,7%
		% Total	20,0%	10,0%	1,7%	,0%	31,7%
	13-18	N	4	13	4	1	22
		% within age groups	18,2%	59,1%	18,2%	4,5%	100,0%
		% within LE input	20,0%	39,4%	<b>66,7%</b>	<b>100,0%</b>	36,7%
		% Total	6,7%	21,7%	6,7%	1,7%	36,7%
	19-30	N	4	14	1	0	19
		% within age groups	21,1%	<b>73,7%</b>	5,3%	,0%	100,0%
		% within LE input	20,0%	42,4%	16,7%	,0%	31,7%
		% Total	6,7%	23,3%	1,7%	,0%	31,7%
	Total	N	20	33	6	1	60
		% within age groups	33,3%	55,0%	10,0%	1,7%	100,0%
		% within LE input	100,0%	100,0%	100,0%	100,0%	100,0%

**Table 2** Achievement of second language learners (determined by age) in the dichotic hearing test: nonwords converted in words.

			Dichotic Hearing Test- Conversion (n° of reports)					Total
			0	1	2	3	4	
Age groups	7-9	N	3	6	1	0	0	10
		% within age groups	30,0%	60,0%	10,0%	,0%	,0%	100,0%
		% within conversion	17,6%	23,1%	7,7%	,0%	,0%	16,7%
		% Total	5,0%	10,0%	1,7%	,0%	,0%	16,7%
	10-12	N	1	7	1	0	0	9
		% within age groups	11,1%	77,8%	11,1%	,0%	,0%	100,0%
		% within conversion	5,9%	26,9%	7,7%	,0%	,0%	15,0%
		% Total	1,7%	11,7%	1,7%	,0%	,0%	15,0%
	13-15	N	7	6	2	0	0	15
		% within age groups	46,7%	40,0%	13,3%	,0%	,0%	100,0%
		% within conversion	<b>41,2%</b>	23,1%	15,4%	,0%	,0%	25,0%
		% Total	11,7%	10,0%	3,3%	,0%	,0%	25,0%
16-18	N	3	1	2	0	1	7	
	% within age groups	42,9%	14,3%	28,6%	,0%	14,3%	100,0%	
	% within conversion	17,6%	3,8%	15,4%	,0%	<b>100,0%</b>	11,7%	
	% of Total	5,0%	1,7%	3,3%	,0%	1,7%	11,7%	
19-23	N	1	3	4	3	0	11	
	% within age groups	9,1%	27,3%	36,4%	27,3%	,0%	100,0%	
	% within conversion	5,9%	11,5%	30,8%	<b>100,0%</b>	,0%	18,3%	
	% Total	1,7%	5,0%	6,7%	5,0%	,0%	18,3%	
24-30	N	2	3	3	0	0	8	
	% within age groups	25,0%	37,5%	37,5%	,0%	,0%	100,0%	
	% within conversion	11,8%	11,5%	23,1%	,0%	,0%	13,3%	
	% Total	3,3%	5,0%	5,0%	,0%	,0%	13,3%	
Total	N	17	26	13	3	1	60	
	% within age groups	28,3%	43,3%	21,7%	5,0%	1,7%	100,0%	
	% within conversion	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	
	% Total	28,3%	43,3%	21,7%	5,0%	1,7%	100,0%	