Journal of Literature, Languages and Linguistics
ISSN 2422-8435 An International Peer-reviewed Journal
Vol.25, 2016
www.iiste.org

Adult Second Language Speakers Who Pass off as Native Speakers: Seeking Plausible Explanations from a Network of Interdisciplinary Research

Zakaria Ahmad Abuhamdia
Middle East University, Amman, Jordan

Abstract
Normal infants and young children who are exposed to a second language over a substantial period of years in its natural interactive community grow up to speak the second language with the native accent of that language. This is a universal observation, commonly giving rise to a common belief that children 'are better than adults at language learning'. In some cases, the second language may even replace the first language. By default, being exposed to another language after that 'early' age generally leads to speaking that language with a foreign accent. The common explanation for the foreign accent is brain sensory-motor maturity in neural pathways. The phenomenon of foreign accent has received and continues to attract research. On the other hand, a relatively small group of adults present a native-accent pattern. They sound native although they learned the second language at an older age, after the 'critical period' (CP) and/or under less natural contexts. This research focuses on this 'phenomenal' group of speakers. The rationale of the focus stems from the fact that these cases are documented in research (e.g., Munoz and Singleton, 2007 and Scovel, 1978) as partial evidence against CP age limits on the plasticity of the human brain for sound perception and sound production.
Key words: foreign accent, accent free speech, adult second language speakers, brain structure, brain function

I. Introduction

The speech of native speakers of a language, say English for an example, may show phonological features that are typical of a particular region, an accent. For instance, there is a New England accent, a Southern accent, or a (UK) Brummie accent. William Labov's pronouncement that everybody speaks a dialect can be extended to saying that everybody speaks with an accent. All human natural languages have localized accents that serve essential symbolic local identity functions. The Biblical shibboleth test is a classic example of how local identity pronunciation betrays, or reveals, the origin of the speaker. This differentiation is perfectly natural in the context of a single language. However, once a person becomes bilingual in two or more languages, other factors come into play. In general, total immersion of a child into the social interactive environment of the second language and/or attending (nursery and/or kindergarten) school in that language result in the acquisition of such language as if it was the first language. (Moyer, 2013; Munoz and Llanes, 2014) Children growing up in bilingual families in which two (or more) languages are used also become native speakers of the languages concerned (simultaneous or sequential acquisition), despite some intervening delays in some cases.

However, if the learner is older, another influential factor intervenes and makes a difference in the learning process and its outcome. That factor is the native language of the learner. Its influence is most apparent in the speech of the learners who are exposed to the other language either for only in intermittent periods, such as just the classroom teaching hours, or at an advanced childhood age, post-puberty. In speaking the second language, their speech is marked by what has become known as the 'foreign language accent'. In fact, writers from Shakespeare's time, or possibly earlier, have realized and depended on the use of non-native accents in the depiction of characters in certain socially projected or stereotyped ways. The practice survives in the media today for achieving the projected purposes. (Dragojevic, Mastro, Giles & Sink, 2016; Ghazi-Saidi, Dash & Ansaldo, 2015)

II. A General Framework and a Specific Focus

The topic of foreign accents continues to attract scholarly attention in the form of annual workshops, conferences, research papers, and books. Moyer (2013), the author of one of the very few book-length works on foreign accents, has described the phenomenon of foreign accents as a 'mystery' still seeking an explanation. Most published research, and general public observations, believe that early childhood is the best time for learning and speaking another language without a foreign accent. Others believe this period may extend beyond early childhood to the age of puberty. (Bongaerts, 1999; Munoz, 2014; Scovel, 1994; and Singleton 2005) This 'best period' has been given the label of 'the critical period' (CP), with more than one expressed position about its mechanisms and period. There seems to be a consensus among researchers that CP refers to the plasticity of the brain, i.e., its readiness to respond efficiently to the linguistic stimuli from the rich surrounding environment. In short, the brain's developmental anatomy and/or functions are at the roots of the issue. The differences of position only concern the time when the plasticity of the brain is still sufficiently functional to effectively block

(or significantly minimize) the adverse effects of the already established sound system of the first language on the perception and production of the sound system of the new language.

Before the invention and use of advanced technology-based means of measurements and of probing brain anatomy and functions (e.g., event related potential, magneto encephalography, functional magnetic resonance imaging, and imaging synaptic density in the living human brain as described by Finnema, et al., 2016), the typical explanation was basically in qualitative terms of description (e.g. brain development, plasticity) not in quantitative measurements. Now with quantitative descriptors available, research on brain development and changes has effectuated leaps of progress. This has given researchers better access to mapping neural connectivity in the living human brain, and most recently measuring the speed of synaptic formation. The focus of this research is on what could possibly underlie the ability of phenomenal late-childhood and adult second language learners to be judged by native speakers as native speakers

III. The First Use of the Term 'Critical Period' Regarding Language

The term 'critical period' first came into use in the work of brain neurologists Penfield and Roberts in the 1950s. In their *Speech and Brain Mechanisms* (1959), they connected the acquisition of a first language by normal healthy (and verbally cared for) babies to the period from birth to that of the early childhood lateralization of many brain functions, a form of division of labor between the right and left hemispheres. That is, lateralization puts a limit or an end to the plasticity of the brain to trigger the latent capacity of the baby (the FOXP2 gene series) for first language acquisition. In this aspect, language functions are assigned to certain areas in the left hemisphere (for right-handed individuals) (Wernicke's area, Broca's area, and the corpus fasciculus connections). Penfield and Roberts and other neurologists, e.g., Jung, Geschwind, Gazzaniga, and Lenneberg, gradually added further details and specifics (which are not essential to the line of presentation here).

As the pace of lateralization increases, researchers noted, the plasticity of the brain decreases, and so does an accompanying process. Lateralization is accompanied (and augmented) by myelination, a process of covering neuronal axons (which carry the message pulses) with white matter, myelin. The white matter sheath not only insulates the axons but also makes them much faster (up to 50 times) and consequently more efficient than before. (Fields, 2014)

There is no consensus among specialists as to the end-point of myelination, similar to differences among scholars on the time of the lateralization processes. However, with more advances in neurology and neural surgery, some informative indications come from hemispherectomy, the removal of the left hemisphere, the language dominant hemisphere for right handed individuals. This surgical procedure is done on infants and some older children for treating certain epileptic syndromes, e.g., Rasmussen's or Sturge-Weber syndrome. (Danelli, et al., 2013) The success of these operations on individuals in early-childhood years lends support to the view that the lateralization of brain functions seems to be nearly complete by early childhood. Following the operation, the language functions of the (removed) left hemisphere are taken over by the patient's right hemisphere, provided it is functionally intact. In the cases reported in the literature, hemispherectomy of the language-dominant, left, hemisphere does not result in any significant loss of (first) language functions if the procedure is done before the age of five and when it is followed by a regimen of physical and speech therapy. Older children who had undergone the same operation showed some language problems especially with the pronunciation of some word types. (Danelli, et al., 2013) Some of these children made headlines on TV networks in the US and other countries. Operating surgeons have not yet identified which parts in the right hemisphere receive and carry out the functions of the removed left hemisphere. The successes of hemispherectomy operations of this type apparently draw a time-line with fading effects of brain plasticity for first language development.

From the above, it may be argued that perhaps there is a time-line with fading boldness for speaking a second language without a foreign language accent, as the next section tries to propose.

IV. Observing the Phenomenon of Foreign Accent

The concept of CP for first language acquisition has crossed from neurology and first language acquisition to second language learning with regards to accent. It has become pivotal in the ongoing debate on foreign language accents. A seminal study (Scovel, 1969) addressed the issue of the role of age and accented speech in second language learning. The study attributes foreign accents of adult second language learners to brain lateralization and concomitant end of its neural plasticity. Post pubescent learners of a second language, even those immersed in the second language social context, speak that language with a foreign accent although they may be very fluent, proficient, and eloquent in the second language, e.g., Joseph Conrad (the famous English writer of Danish origin) and Henry Kissinger (who migrated to the US at the age of 14 and became the US Secretary of State during the Nixon and Ford administrations in the late 1960s until Jimmy Carter became President in January 1977). On the other hand, young children in the same environmental context pick up the

native accent within a comparatively short period after immersion in the social and educational environment. (Archila-Suerte, Zevin, and Hernandez, 2015, and Moyer, 2014)

Scovel's paper came out at a time when the field of applied linguistics and language teaching was sprouting in both the UK and USA. Foreign language teaching specialists turned their attention to the pronunciation deviations made by the learners. With publications on how languages differ in structure, contrastive linguistic studies tried to account for the problems of learners by reference to the native languages of the learners. The position was that the culprit in learner's errors was mainly the first language. A comprehensive leading work is a dissertation written by Selinker in 1966. Its gist is that the errors result from wrong/negative transfer of phonetic features from the native language to the second language. In effect, the first language systems form the benchmarks in second language learning. (Selinker, 1966) About the same time, the reasoning underscored the importance of investigating the resulting errors of the learners. *The Significance of Learners Errors* by S. Corder highlighted the value of research on contrastive linguistics for the practitioner of second language teaching. (Corder, 1967) This attention among language teaching practitioners and/or specialists led to the rise of error analysis as another subarea in language teaching and learning. (Richards, 1974) Learner's errors in pronunciation, word formation, word meaning, and grammar, were classified according to different criteria as to their sources, e.g., first language, learning strategy, misinterpreting second language rules, and teaching materials and also whether they were global errors or local errors, and transient errors versus fossilized errors, and so forth. In hindsight now, those ideas may be considered the forerunners of recent concepts in the CP literature such as neural commitment, first language magnet, first language bias, perceptual assimilation, and phonological filtering in the perception of the sound system of the second language and, subsequently its production by the learners. (Pajak and Levy, 2014)

As speech sounds get to the ears of the listener(s), phonetic features of foreign accent were favorite topics for numerous research degrees in applied linguistics, e.g. bilingualism, psycholinguistics, second language teaching. A 1979 PhD dissertation by Flege involved conducting an acoustic test on consonant voicing, /b/ vs. /p/, in English as spoken by Saudi students learning English in US. As their native language, Arabic, does not have the voiceless member of the pair as a phoneme, [a sound that brings a semantic difference between identical sequences of sounds, but allophones of the same /b/ phoneme,] those students failed to make the phonemic distinction consistently in English. (Flege, 1979) From the earliest times of interest in foreign accents, studies have shown foreign accent to be more pronounced in the speech of second language learners as their age of beginning the learning process advances after the period of early childhood. This starting point (of second language learning) goes by several terms in research, e.g. age of acquisition, age of arrival, age of onset, age of immersion, and age of intensive exposure. Despite the differences in the details of these conceptual terms, there is a general agreement that advanced age is the primary factor for the rise and general persistence of foreign accent. Some studies have attributed this to the dwindling neural plasticity of the brain, e.g., Golestani, Molko, Dehaene, LeBehan, & Pallier (2007); Guediche, Holt, Laurent, Lim, & Fiez (2015), while others, e.g., Moyer (2014) and Munoz (2014) have named contributing catalytic factors such as self-concept, motivation, language aptitude, intensity of interaction, willingness to communicate with native speakers, and an orientation for social integration in the new community. Golestani, Molko, Dehaene, LeBehan, & Pallier (2007) also argue for a multi-faceted situation. All authors agree on the primary role of the age of the learner. (Archila-Suerte, Zevin, and Hernandez, 2015)

No consensus obtains among scholars in the field on a specific age limit for neural plasticity. In a series of experiments on the ability of nine-month-old babies to perceive sounds from more than one language, a team of researchers, led by Patricia Kuhl, found that babies at that age were receptive to a variety of sound systems just like their native languages, calling babies 'world citizens'. However, by the end of the first year, the infants were much less receptive to distinctions in sound features that were not part of their earlier experience. i.e., not world but specific contexts citizens. (Kuhl, et al., 2008) But these experiments were not extended to babies or infants and young children being raised in two (or more) languages (inside and/or outside the family contacts, e.g., school and playground) and who grow up to speak each language with a native accent. Therefore, however valid the findings are about babies of that age may appear, this is not the whole story. The first year does not obviously close the brain's phonetic plasticity. Sequential infant bilingualism is common in many countries. Furthermore, accent-free speakers are realities within migrant families, internationally adopted infants and children, and young children of expatriate families living in socially open and mixed environments away from their home countries. (Pallier, 2013; Pallier, et al. 2003; and Scovel, 1969) In documented cases of international adoptees, the first language of those adopted at an age of up to eight years was totally lost, and so was their ability to recognize sound distinctions in their first acquired language. The adoptees were from Korea and were brought up in rural France. In 2003 and 2005, they, together with cohorts of native French native speakers, were tested on sound distinctions made in Korean but not in French. The Korean adoptees, whose ages ranged from one to eight years at adoption, did not have an edge over the French born children. (Pallier, et al., 2003) Ten years later, the same results were obtained about the same subjects when the same Korean-born subjects and

their cohort French speaking subjects were tested on recognizing sound distinctions made in two languages which are unrelated to French and Korean, Polish and Japanese. (Pallier, 2013) The conclusion from these results, at least with regard to this sample, is that a first language brain neural paths may be lost and the neural synapses may be pruned or eliminated from the brain. The structure of the brain related to sound perception may undergo changes due to the influence of significant social contexts, an aspect debated in epigenetics. The following section depends on such propositions for the purpose of trying to identify plausible bases for accent-free speech by adult second language speakers.

V. Rejuvenated / Restored Brain Plasticity of the Exceptional Group

Infancy is the best period for speaking a second language without a foreign accent whereas older second language learners will very likely speak it with a foreign accent. That is a generally accepted proposition that real life facts support. However, the second part of the proposition in the first sentence does not seem to apply to all older second language learners. Studies have referred to individuals who do not fit the commonly made generalization. (Golestani, Molko, Dehaene, LeBehan, & Pallier, 2007; Scovel, 1978; Scovel, 1994; and Singleton and Lengyel, 1995) There could be some underlying factors that make this group excel in speech. The following is an attempt at trying to travel an unpaved road, so to speak, to combine what is potentially relevant to the focus from the previous sections with what can provide stepping stones in a plausible direction. Since the available literature only mentions such cases as counterexamples against the arguments for setting a deadline for brain plasticity, one way of indirectly addressing the point goes through the possibly relevant findings in studies on brain anatomy, structure, and function.

For researchers who produce the cases of the exceptional second language speakers, CP/brain plasticity is not an either on-or-off mechanism. Rather, it is a continuum. For others, it ends by the age of puberty, and this seems to true about the overwhelming majority of adult second language speakers. Furthermore, hemispherectomy also adds substance to the generalization about the majority. But it also keeps the window open for the understanding cerebral changes in the language-relevant parts of the brains of the minority of accent-free adult speakers. Operations of left hemispherectomy summarized above have shown that left hemisphere functions were not lost in the wake of the removal of the left hemisphere. The intact right hemisphere served those functions, following regimens of physical and speech therapy. However, it was clear that the younger the patient at the time of the procedure (by eight to ten years at most), the more successful the transfer of language functions to the right hemisphere. For them speech neural plasticity was well and functioning. After that age, the patients who underwent the procedure had recovered less than satisfactory/normal verbal behavior after the operation, especially on speech. For this group, speech neural plasticity was declining significantly enough for language problems to remain. Apart from those problems, the cognitive functions of those patients enabled some to go to college and get degrees. These results of hemispherectomy point to the likelihood that for some people brain plasticity (permitting transfer of functions) may extend beyond infancy to puberty or even after that age. What makes it extend in time may be related to both the brain and the environment of the individual. In this context, furthermore, the stimuli received by the individual may engender non-pathologically induced neural changes in the brain leading to uncommon but language-appropriate responses and conditions. Thus, neural connections may change in both structure and function guided by experience. In effect, then, the adult brain, under normal healthy physical conditions for some, could undergo changes in structure and/or function in a particular region. Sale, Berardi, & Maffei, 2014 Relevant brain research argues that different brains may have different characters, and they may develop in different ways ‘under the influence of genetic and environmental factors’, and with a rewarding environment, responses by the individual ‘tend to be repeated and consolidated.’ (Catani and Bambini, 2014:165) The (molecular) brakes placed on neurons (effectuating the closure of the CP) to block their versatile perception-formation through myelination may be released and the sound-perception versatility may be restored. (Werker and Hensch, 2015: 175 – 176)

To the extent that this characterization may be language-related, perhaps the brains of the exceptional learners have, or develop, neural wiring for speech that is different from that of most second language learners of their age. This position stems from what may be gathered from a study on the plasticity of the brain and pharmacotherapy. (Sale, et al., 2014) The study cites four earlier studies on speaking and reading aloud (two aspects of language in which accent is usually evident). The studies aimed at assessing the role of ‘an enriched environment, under non-pathological conditions’, on neural genesis in the brains of the adult subjects. The exposure of the subjects to the rich environment led to birth of new neurons and connections in the (hippocampus of the) brain. This part is thought to have a role pertinent to the presence or absence of an accent. It may reasonably follow from this role that the ‘critical period may reopen regardless of age in response to sensory experience.’ (Werker and Hensch, 2015:175) Other authors (e.g., Berken et al., 2014, and Sale, et al. 2014) also suggest that there are varied critical periods for varied functions that also vary by individuals. (Berken, et al., 2015) Each of these periods has three phases: an opening, duration, and an end. The reopening

results from lifting the 'brakes' placed on the cellular substrates involved in sound perception. Synapses that were pruned, suppressed, or eliminated come back. In addition, new synapses may be formed. In sum, 'plasticity can be reinstated.'(Werker and Hensch, 2015: 188) If so, the ability to speak a second language at an advanced without a foreign accent may be achieved. Further enlightenment comes from the measurement of the myelin sheath covering neuronal axons of adult second language speakers in the left auditory cortex. (Golestani, Molko, Dehaene, LeBehan, & Pallier, 2007) In their study, the subjects were divided into two groups: fast learners and slow learners, based on a specific test of distinguishing the two Hindi dental and retroflex /d/ sounds. In Hindi, these are two different phonemes that contrast otherwise identical words. The different acoustic properties of these phonemes are in the first 30-50 milliseconds of the sounds. That is, distinguishing them requires a fine time threshold. [For the Hindi native speaker, this is a subconscious natural task, just similar to the ability of native speakers of (American) English to distinguish the fine distinction in length of the first vowel in *writer* and that in *rider*.] Fast learners recognized the phonemic difference while the slow learners did not. Then the thickness of the white matter in the sound perception area of the brain's left hemisphere (Heschl's gyrus) was measured by non-invasive means. It was found to be thicker in the faster group than in the slower group. To triangulate testing of these findings, Golestani and co-researchers conducted a reanalysis of data about subjects they had studied five years earlier. The reanalysis showed similar results about the role of higher white matter thickness in the same area. Two later studies (Klein, 2014 and Reiterer, Xiaochen, Sumathi, & Sing, 2013) on issues related to white matter thickness and second language speakers also give more plausibility to the change that may take place in the brains of some older (than early childhood) second language speakers.

If this applies to the exceptional second language speakers, it is probable that these speakers perceive and thereby produce the phonetic features of the second language that are not perceived by the overwhelming majority of second language learners of the same age. If this sensory perceptual advantage is augmented by the socio-psychological orientation of the learner towards the second language, it is likely that these speakers acquire the native accent of the second language.

Another study, (Simmonds, 2015) extrapolating from an earlier study by Simmonds and co-researchers (Simmonds, et al., 2014), draws parallels between human beings and song-learning birds (having different brain structure from that of birds which do not learn songs e.g., chickens). Both these birds and human beings engage in vocal learning. The research conclusion concurs with the proposition that (brain) perception and production pathways of first language acquisition are decommissioned in early childhood, thus making the learning of phonetic features of new languages a challenge for the learner. The outcome is speaking with a foreign accent. The researcher conjectures, on the other hand, that if the two pathways are recommissioned/reactivated later in life, this 'may enable mastery of native-like accent in the second language by adult learners. (Simmonds, 2015: 5)

VI. Conclusion

Taking a focus in relation to foreign language accent away from the typical discussion of why do older second language learners speak it with an accent that reflects their native languages, this research has opted to focus on the untypical, exceptional second language learners. Its goal was to look into those who are judged by native speakers as native speakers when in fact they are not. The goal is not to distract from the worthiness of the typical but to draw the attention to the untypical by trying to glean propositions and conclusions from fields such as neurology, neurosurgery, pharmacology, and epigenetics in order to construct a tentative basis for sound perception and sound production by adult second language learners who pass off as native speakers.

VII. References

1. Archila-Suerte, P., J. Zevin, and A. Hernandez. 2015. 'The effect of acquisition, socioeducational status, and proficiency on the neural processing of second language speech sounds.' *Brain and Language* **141,** Feb. 2015, pp.: 35 – 49

2. Berken, J., Jonathan, L. Vincent, J. Chen, K. Watkins, S. Baum, M. Callahan, & D. Klein. (2015). 'Neural activation in speech production and reading aloud in native and non-native languages'. *NeuroImage* **112:** 208 – 217

3. Bongaerts, T. (1999) 'Ultimate attainment in foreign language pronunciation: the case of very advanced late language learner', in *Second Language Acquisition and the Critical Period,* D. Birdsong, Ed. (Mahwah, New Jersey: Erlbaum), pp. 133 – 159

4. Catani, M., V. Bambini, (2014) 'A model for social communication and language evolution and development.' *Current Opinion in Neurobiology* **28:** 165 – 171

5. Corder, S. (1967) 'The significance of learners errors.' *International Review of Applied Linguistics* **5:** 161 – 170 (Expanded to a book published 1981).

6. Danelli, L., G. Cossa, M. Berlingeri, G. Bottini, M. Sberna, & E. Paulesu (2013) 'Is a lone hemisphere enough? Neurolinguistic architecture in a case with very early left hemispherectomy. *Neurocase* **19** (3): 209 – 231

7. Dragojevic, M., D. Mastro, H. Giles, & A. Sink. (2016). 'Silencing non-standard speakers: a content analysis of accent portrayals on American primetime television.' *Language in society* **45**: 59 – 85

8. Fields, R. (2014). 'Myelination: more than insulation.' *Science* 344 (6181): 264 – 266

9. Finnema, S. et al. (2016). Imaging synaptic density in the living human brain.' *Science Translational Medicine,* 8 (348): 348ra96

10. Flege, J. (1979) Interference in second language acquisition. Unpublished PhD dissertation. Indiana University, Bloomington

11. Ghazi-Saidi, L., T. Dash, & A. Ansaldo, (2015) 'How native like can you possibly get? fMRI evidence for processing accent.' *Frontiers in Human Neuroscience* 9: 587

12. Golestani, N., N. Molco, S. Dehaene, D. LeBehan, & C. Pallier. (2007). 'Brain structure predicts the learning of foreign speech sounds.' *Cerebral Cortex* **17:** 575 – 582

13. Guediche, S., L. Holt, P. Laurent, S. Lim, & J. Fiez. (2015). 'Evidence for cerebellar contribution to adaptive plasticity in speech perception.' *Cerebral Cortex* **25**: 1867 – 1877

14. Hoz, L., and M. Simons. (2015) 'The emerging functions of oligodendrocytes in regulating neural network behavior.' *BioEssays* **37:** 60 – 69

15. Klein, D., K. Mok, J. Chen, & K. Watkins. (2014) 'Age of language learning shapes brain structure: a cortical thickness study of bilingual and monolingual individuals.' *Brain and Language* **131:** 20 – 24

16. Kuhl, P., B. Conboy, S. Coffey-Corina, D. Padden, M. Rivers-Gaxiola, & T. Nelson. (2008) 'Phonetic learning as a pathway to language: new data and native language magnet theory expanded (NLM-e).' *Philosophical Transactions B* **363:** 979 – 1000

17. Moyer, A. (2013). Foreign *Accent: the Phenomenon of Non-native Speech.* Cambridge: Cambridge University Press.

18. ---------. (2014)' Exceptional outcomes in second language phonology: the critical factors of learner engagement and self-regulation.' *Applied Linguistics* **35**: 418 – 440

19. Munoz, C. (2014) 'Complexities and interactions of age effects in second language learning: broadening the research agenda.' *Applied Linguistics* **43**: 369 – 373

20. ---------- and A. Llanes. (2014). 'Studying abroad and changes in degree of foreign accent in children and adults.' *Modern Language Journal* **98** (1): 432 - 449

21. ---------- and D. Singleton. (2007). 'Foreign accent in advanced learners. Two successful profiles.' *EUROSLA Yearbook* 7: 171 – 190

22. Pallier, C. (2013). 'Age effects in language acquisition and attrition' in *Birdsong, Speech, and Language: Exploring the Evolution of Mind and Brain,* J. Bolhuis and M. Everaert, Eds. (Cambridge, MA: MIT Press) pp. 317 – 330

23. --------, J-B Dehaene. D. Poline, D. LeBihan, A. Argenti, E. Dupoux, & J. Mehler. (2003). 'Brain imaging of language plasticity in adopted adults: Can a second language replace the first?' *Cerebral Cortex*. **13:** 155 -16

24. Pajak, B. and R. Levy. 2014. 'The role of abstraction in non-native speech perception.' *Journal of Phonetics* **44**, (2014): 147 - 160

25. Penfield, W. and L. Roberts. 1959. *Speech and Brain Mechanisms.* Princeton*:* Princeton University Press

26. Reiterer, S., H. Xiaochen, T. Sumathi, & S. Nandini. (2013). 'Are you a good mimic? Neuro-acoustic signatures for speech imitation ability.' *Frontiers in Psychology,* **pp.** : 1 - 13

27. Richards, J., (1974) *Error Analysis.* London: Longman.

28. Sale, A., N. Berardi, & L. Maffei. (2014). 'Environment and brain plasticity: towards an endogenous pharmacotherapy.' *Physiological Reviews* **94:** 189 – 234

29. Scovel, T. (1969). 'Foreign accents, language acquisition and cerebral dominance.' *Language Learning* XIX (3-4): 245 – 253

30. ----------. (1978).'The recognition of foreign accents in English and its implications for psycholinguistic theories of language acquisition' in *Proceedings of the Fifth Congress of the International Applied Linguistics Association.* (Montreal: Laval University Press) pp. 389 – 401

31. ----------. (1994) 'Differentiation, recognition, and identification in the discrimination of foreign accents" in *Phonological Acquisition and Phonological Theory,* J. Archibald. Ed. (Mahwah, New Jersey: Erlbaum) Pp.: 169-181

32. Selinker, L. (1966). A psycholinguistic study of language transfer. Unpublished PhD dissertation, Georgetown University, Washington, DC

33. Simmonds, A. (2015) 'A hypothesis on improving foreign accents by optimizing variability in vocal learning brain circuits.' *Frontiers in Human Neuroscience* **9**: 606 – 622

34. ----------, R .Leech, P. Inverson, & E. Wise. (2014) 'The response of the anterior striatum during adult human vocal learning.' *Journal of Neurophysiology* **15:** 792 – 801

35. Singleton, D. (2005). 'The critical period hypothesis: a coat of many colours.' *International*

36. ---------- (1995). 'Introduction: a critical look at the critical period hypothesis in second language acquisition research', in *The Age Factor in Second Language Acquisition Research,* Eds. D. Singleton and Z. Lengyel. Eds. (Multilingual, London 1995). Pp.: 1 – 29

37. Werker, J., and T. Hensch. (2015). "Critical periods in speech perception: new directions.' *Annual Review of Psychology* **66**: 173 – 196