

# Hemispheric Lateralization and Language Learning: Neurolinguistic Considerations

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This paper reviews research on hemispheric lateralization. There are neurological evidences for the lateralization of speech and language functions and inter- and intrahemispherical differences between males and females. The results for the study of lateralization and bilingualism are mixed, proving the complexity and multidimensionality of lateralization.

*Keywords:* hemispheric lateralization, gender, bilingualism

The human brain is the faculty of cognitive abilities and language is the essential ability distinguishing human beings from other animals. Investigation into the division of labor between the left hemisphere (LH) and right hemisphere (RH) of human brain in language matter is of fundamental significance. Knowledge on and insight into the neurological mechanism for language are very likely to aid recovery of language skills in those with brain damage or language impairment and to contribute to the development of language (whether it is the mother tongue, a foreign language or a second language) skills and even to the all-around development of students when teachers' pedagogical practices are accordingly informed.

This paper aims to provide a general overview on the hemispheric lateralization of language functions. The research questions are:

1. How are language functions lateralized to the two hemispheres?
2. How does hemispheric lateralization vary across gender?
3. What is the relationship between lateralization of language functions and bilingualism?

## **Hemispheric Lateralization of Language Functions**

The cerebral hemispheres of the brain are functionally specialized. Hemispheric lateralization study originates in lesion deficit studies which point to the view that the left cerebral hemisphere (LH) is specialized or dominant for language functions, particularly grammar and phonology whereas the right hemisphere (RH) is important for the processing of semantic and pragmatic aspects of language.

There are neurological evidences for the lateralization of speech and language functions. According to Foundas, Leonard, and Heilman (1995) and Falzi et al. (1982), the amount of grey matter in Broca's area and planum temporale is larger than that in the corresponding area in the right hemisphere; the truncus fissurae of LH is longer than that of RH. Moreover, arcuate fasciculus of LH is longer and denser (Hagmann et al., 2006; Propper et al., 2010).

Corina, Jyotsna, and Bellugi (1992) believed that the left hemisphere predominantly mediates language skills. The basis of this lateralization is the differential localization of the linguistic, the motoric, or the symbolic properties of language. Lateralization of spoken language, signed language, and nonlinguistic gesture have been compared in deaf and hearing individuals in three experiments. The analyses of experimental results and additional clinical findings provided supporting evidence for the linguistic specificity of left hemisphere dominance or specialization for language.

Thompson (1984) mentions an amazing array of dichotomous models attempting to account for functional differences between the human cerebral hemispheres since the early 1960s, and lists characterizations of differences between the left and right hemispheres as verbal versus visuospatial (Kimura, 1961), as analytic versus holistic/gestalt (Galín, 1974; Nebes, 1978), serial versus parallel (Cohen, 1973), and as being analytic, chronic logic-chopping, “talking” whereas intuitive, esthetic, and “feeling” in popular media.

Cai, Haegen, and Brysbaert (2013) acknowledged that language production and spatial attention are among the best-established human cerebral functions known to be lateralized (i.e., specific to the left or right side of the brain). Neuroimaging techniques have confirmed that language production is left lateralized in most humans, whereas spatial attention is right lateralized. They tested the Statistical hypothesis (complementary specialization is a statistical phenomenon rather than a casual phenomenon) and Causal hypothesis (spatial attention performance will be crowded out from the language-controlling hemisphere to avoid interferences) in a group of healthy human volunteers with atypical language lateralization. The results provide neuroimaging evidences supporting of the Causal hypothesis and against the Statistical hypothesis.

Brueggemann (1989) explored the relationship between brain lateralization and writing by reviewing some relevant studies. Nebes’ research studied the cognitive functions of both hemispheres and concluded that the left brain suppresses or represses right-brain language functions in writing and that the right brain often cannot “verbalize” or “express” although it appears to know and understand language. Benjamin Glassner (1982) tested 24 college students, using EEG brain scans, to determine activation of right and left hemispheres in two writing assignments. He concluded that students “must experience that the search for something to say is as critical as the ability to say it” (p. 10). Brueggemann (1989) commented that most real world writing tasks and problems are complex and require various cognitive activities, so the two hemispheres should be both involved. Brueggemann (1989) also noticed difficulties of brain lateralization research, such as the selection of research subjects, the inability to develop and explain clearly how humans develop lateralization in the first place which is regarded by him as a fundamental problem with the research on right-/left-brain specialization.

Bradshaw and Nettleton (1981) blow a different tune by reminding scientists and scholars concerned with the human brain study that considerable modern evidences argue against rigid dichotomies in the interpretation of hemispheric functions and in favor of continuities. They point out that major differences between hemispheres may be of degree, not kind differences in degree rather than in kind. They brought out changes to brain hemisphere research and traditional beliefs about right brain and left brain functions. The dichotomy of cerebral lateralization is thrown into criticism.

### **Lateralization and Gender**

Girls are generally assumed to be better language learners. Are there neurological evidences supporting this assumption?

Males and females seem to differ inter- and intrahemispherically. As far as language functions are concerned, it is generally believed that women use both hemispheres more equally whereas men are more strongly lateralized to the left hemisphere (Kansaku, Yamaura, & Kitazawa, 2000). Ingallhalikar et al. (2014) conducted a meta-analysis of 29 studies comparing language lateralization in males and females and did not find any obvious differences. However, Andreano, Dickerson, and Barrett (2014) studied 949 individuals aged 8-22 years by using diffusion tensor imaging and mapped notable differences in male and female neural wiring. They concluded that in all supratentorial regions of the brain inter-hemispheric connectivity was greater in women's and girls' brains, whereas intra-hemispheric connectivity was greater in the brains of men and boys. The detected differences in neural connectivity became much more prominent in the 14 to 17-year-old. The general conclusion reached by the authors is "Overall, the results suggest that male brains are structured to facilitate connectivity between perception and coordinated action, whereas female brains are designed to facilitate communication between analytical and intuitive processing modes".

### **Lateralization and Bilingualism**

Initial hemispheric lateralization study focuses on monolinguals. When it comes to bilingualism or even multilingualism will a different picture be presented? What are the roles of LH and RH for the acquisition of a second or a third language after or before lateralization as far as a critical or sensitive period for the second language acquisition is concerned?

There are different hypotheses as to the organization of languages in the brain of bilinguals: All languages are localized in the same areas (Freud, 1891; Minkowski, 1963; Pitres, 1895/1983); all languages are localized in separate areas with the native language (L1) residing in Broca's area and other languages spread forward from there (Scoresby-Jackson, 1867); bilinguals develop centers for language functions, such as selecting a language, switching between languages, and translating (Pötzl, 1930); all languages are localized in the same areas but have separate neural circuits involving separate nerve cells (Minkowski, 1963). With the publication of *The Bilingual Brain* by Albert and Obler, lateralization of language abilities and bilingualism attracted more attention.

Seliger (1982) paid special attention to the RH by taking into consideration the language functions performed by the right hemisphere after the centralization of the first language in the left hemisphere, the linguistic role of the right hemisphere after lateralization, and the role of right hemisphere functions in the second language acquisition process as opposed to the language maintenance process. He claims that the right hemisphere has many functions which may play an important role in second language acquisition. He also mentions that since the hemispheres interact at both the cortical and subcortical levels, it is best not to teach to one hemisphere exclusively.

Genesee (1982) focused on the growing body of literature dealing with neurolinguistic investigations of bilinguals. He begins with clinical studies of bilingual aphasia and finds that the two languages of the bilingual do not appear to be subserved by different neuropsychological substrates. In addition, he examines the experimental studies of bilingualism on the extent of right hemisphere involvement in second language processing and comes to the conclusions as follows: (1) There may be greater right hemisphere involvement in language processing in bilinguals who acquire their second language late; (2) there may also be greater right hemisphere involvement in bilinguals who learn their second language in informal contexts; and (3) there is little evidence that either stage or level of second language proficiency plays an important role in differential

hemispheric processing in bilinguals. Genesee notes the lack of consistency across research studies and the limited set of linguistic structures investigated (usually lexical items).

Dehaene et al. (1997) report the more involvement of RH than it is in L1 processing in PET and fMRI studies, but it is more likely to be “the result of the greater role that pragmatic factors play in compensating for the speaker’s poorer proficiency in second languages (L2)”.

Hull (2003) sought to test the claim that multiple language acquisition alters the pattern of brain functional asymmetry for language and aimed to address a range of findings concerning the functional cerebral lateralization of L1 and L2 of bilinguals by conducting meta-analysis on 71 experimental studies of cerebral lateralization for language in brain-intact bilingual’s studies that used behavioral paradigms to assess bilingual laterality. The questions examined include: (1) Does cerebral asymmetry for each language vary as a function of the age at which bilinguals acquire each of their languages? (2) Does lateralization vary as a function of the fluency level attained in each language? (3) Regardless of group, are tasks that involve language processing at a global level lateralized differently than those involving local, word level processing? (4) Are the two languages of bilinguals lateralized similarly or differently? (5) Is the pattern of lateralization influenced by whether a bilingual’s two languages are structurally or typologically similar vs. dissimilar? (6) Is lateralization influenced by response mode, i.e., whether responses are articulated vs. given in other form? And (7) Are bilingual men lateralized differently from bilingual women? The predictive value of a number of theoretically identified moderators of cerebral asymmetry for language was assessed, namely, the age of L2 acquisition, fluency in the L2, participant sex, experimental paradigm, linguistic task demands, relatedness of L1 and L2 structures, and context of language use. The results indicate that the functional cerebral lateralization is similar for first and second languages of bilinguals and the age of L2 acquisition significantly influences the directionality of functional lateralization for language.

### Conclusion

To conclude, there is still a long way for the investigation into the lateralization of language abilities in the brain which proves to be a complex and challenging task to fulfill even with the advancement of modern technologies and their applications into the neurolinguistic study as the brain is one of the greatest mysteries of all. “Who or what is the ultimate decision-maker as to which side of the brain should be dominant and call the tune, or relinquish control at a given moment is still an unanswered and perhaps unanswerable question” (Ehrenwald, 1984, p. 215).

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