On the Relationship between Brain Laterality and Language Proficiency in L2: A Replication Study

Nima Shakouri
Department of English, Science and Research Branch, Islamic Azad University, Tehran, Iran
nimashakouri55@gmail.com

Parviz Maftoon
(Corresponding author)
Department of English, Science and Research Branch, Islamic Azad University, Tehran, Iran
pmaftoon@srbiau.ac.ir

Abstract

The present paper attempted to investigate whether there is any significant relationship between participants' brain laterality and L2 proficiency level. To carry out the experiment, 30 participants administered in the present study. Fifteen of them did not have any English language learning experience and were at the start of language learning, while the rest had attended L2 learning classes for about 2 years in a popular English language center, located in Bandar-e Anzali, Iran. Finally, the researchers concluded that the activity of the right hemisphere went up by the increase in language proficiency among bilinguals. Thereupon, the result of the paper was at variance with Albert and Obler's (1978) early work on hemispheric differentiation, which indicated that bilinguals were less hemispheric dominant than monolinguals.

Keywords: Divided Visual Field, Laterality, Left Hemisphere, Right Hemisphere, SLA

1. Introduction

In the early 1970s, neuroscientists came to hold that the right hemisphere plays a vital role in second language acquisition (SLA) (Faruji, 2011). Based on a prevailing hypothesis (i.e., stage hypothesis) raised by Obler, Albert, and Gordon (1975), which was amended later by Galloway and Krashen (1978), bilinguals are initially dependent, to a great extent, upon the right hemisphere, but with an increase in L2 proficiency, they become more left-hemisphere lateralized. Obler (1981), also, contends "the [right hemisphere] participation is particularly active during the early stages of learning L2" (p. 458). Indeed, as to Obler, the very participation is due to strategies of acquisition (e.g., guessing at meanings and using formulaic utterances) which are centered in the right hemisphere.

Although research on brain laterality is not a new topic, it is given a fresh and lively airing in this paper. In fact, "a basic requirement for scientific integrity is the ability to replicate the results of research" (Burman, Reed, & Alm, 2010, p. 787). Accordingly, Abbuhl (2012) contends that replication should be considered as an absolute prerequisite for future research. Schmidt (2009) also contends that replicability is one of the cornerstones of the scientific method, and SLA is not an exception. Thereupon, the present paper endeavored to reinvestigate whether there is any significant relationship between L2 learners' brain laterality and language proficiency.

2. Review of the Related Literature

2. 1. Brain Dominance

Undeniably, human beings' brain is highly interactive (Jensen, 2002). As to Jensen, there are no such things as right-brained or left-brained people. There are only propensities; that is, one hemisphere is more active than another. Caplan (1995) contends that brain "dominance is a preference, not an absolute" (p. 303). Along the same vein, Birjandi and Seyyedrezaei (2012) assert that although functions are lateralized, these functions differ across individuals. In a study carried out by Voyger (1996), the results indicated that males showed more left-brain laterality than females in the visual and auditory modality functions. Even within various language tasks, the degree of dominance might differ. Wagner et al (1998) found out that during a verbal encoding task, greater activation on the left hemisphere is associated with the words that were later remembered, but less involvement on the left hemisphere is seen in words that were forgotten. Besides, Pulvermliller and Mohr (1996) put forth that there was an increase in the right brain involvement when the subjects were required to process the function words, whereas the processing of content words is less strongly lateralized. Similarly, Boeree (2004) contends language functions including grammar and vocabulary are usually lateralized to the left hemisphere, while prosodic language functions (e.g., intonations and stress) are often lateralized to the right hemisphere of the brain (Ross & Monnot, 2008).

That cerebral lateralization for language learning in bilinguals differs from that in monolinguals has also yielded impressive results. Paradis (2000) asserts that both monolinguals and bilinguals make use of the same areas of the brain, but different circuits within these areas are involved. Although a variety of factors gets involved in the nature of cerebral lateralization, including sex, the level of hormones, the language complexity, and the relationship between L1 and L2, research shows more right hemisphere involvement on the part of females for word processing in comparison with males (Shanon, 1982). Parallel to the same conviction, scholars (e.g., Beauchet, 2006) put forth that the level of hormones in the two sexes highly influences brain cognitive functioning. Beauchet, in this regard, maintains that reduced cognitive ability is related to the low levels of testosterone; henceforth, to him "testosterone substitution may improve some aspects of cognitive ability" (p. 773).

Regarding language complexity, Grosjean (1989) asserts that brain involvement during sentence-level processing differs depending on the complexity of the sentence structure. Grosjean maintains that the processing of the words in isolations results in left hemisphere involvement. In contrast, when the sentences containing the same words are processed, more activation on the right hemisphere is resulted.

Moreover, according to Birjandi and Seyyedrezaei (2012), the linguistic distance between L1 and L2 is also a moderating factor in bilinguals' brain lateralization. The bigger the similarity between the structures of L1 and L2, the greater the differences in language laterality.

Based on the abovementioned literature, the present work is a case study to reinvestigate whether the brain laterality has a plausible relationship with learners' language proficiency level.

2.2. Cerebral Asymmetry

Without a doubt, cerebral asymmetry is one of the most basic aspects of the neuropsychological organization of the human brain (Banich, 2003). As to Gur et al. (2000), what makes male brain functioning distinct from female brain functioning is that male brains process information with more asymmetries. Put differently, the asymmetries in male brain are seen in the intrahemispheric activation rather than in the interhemispheric activation (Magon, 2009). Indeed, both sexes regularly use hemispheres of the brain. Nevertheless, females' brain processes language simultaneously in the two hemispheres, whereas males' brain processes the language on the left side earlier.

Parallel to the same argument, evidence accumulated in the literature on monolinguals suggests that the left hemisphere is responsible for processing language (Appel & Muysken, 1987). That is, monolinguals are more hemispheric dominant. However, to several scholars (e.g., Paradis, 1990), the hemispheric asymmetry between bilinguals and monolinguals is vigorously opposed. To Paradis, bilinguals differ neither neuroanatomically nor neurophysiologically. Moreover, Paradis claims that bilinguals can make use of the same cerebral mechanisms that are available to monolinguals. In fact, bilinguals can compensate for gaps in their implicit linguistic competence by relying on their right hemisphere.

2.3. Divided Visual Field

Divided Visual Field (DVF) method has the ability to answer several important questions regarding the lateralization of brain function (Banich, 2003; Bourne, 2006). According to Banich (2003), DVF can play an important role "in aiding our interpretation of important phenomena that have been revealed by more recent methods in neuropsychology, such as functioning brain images (e.g., fMRI)" (p. 61). Regarding the advantages of DVF methodology over neuroimaging technology, Banich asserts that decreases in the working memory capacity among the old are together with changes in brain activation patterns. As a result, more activation in frontal areas during both verbal and spatial working memory tasks among the elderly are observed. A variety of answers can be brought to the table including the inability of neural hardware or the emergence of a compensatory mechanism, but what is crystal clear is that neuroimaging technology, as to Banich, fails to find an answer to the cited question. Banich claims:

> If the bilateral activity is a compensatory mechanism to demanding task conditions, then one would predict that the elderly should exhibit an across-hemisphere advantage at lower levels of task complexity than should younger adults. In contrast, if the lateralized neural hardware for working memory is disrupted, no difference between the younger and older adults should be found with regards to the relative advantage of inter- vs. intra-hemispheric processing. In fact, the elderly resort to coupled processing in the cerebral hemispheres at lower levels of task difficulty/complexity than do younger adults, convincingly demonstrating that neuroimaging findings are a dynamic response of the elderly brain to increased complexity. (pp. 61-62)

Moreover, in the field of SLA, the use of neuroimaging is costly and not easily available to researchers. Henceforth, several scholars (Banich & Shenker, 1994; Diamond & Beaumont, 1972; Poffenberger, 1912) find DVF methodology an easy way of examining a variety of lateralized processes. As to Beaumont (1983), the rationale behind DVF methodology is that a stimulus presented to one visual field is received and processed by the contralateral hemisphere. Nevertheless, easiness in methodology should not be sacrificed at the expense of accuracy. "Strict methodological controls [including the selection of participants, methods of fixation control, presenting stimuli unilaterally, methods of responding, and measures that can be taken] are necessary to maximize the validity of conclusions drawn from DVF studies" (Bourne, 2006, p. 389).

Bourne insists that considering the lateralized process, researchers need to identify the participants with an atypical pattern of asymmetry because they will provide data anomalous. In this regard, inspired by the work of Pujol, Deus, Losilla, and Capdevila (199) who found that 96% of the right-handed people were lateralized to the left hemisphere, Bourne (2006) asserts "one of the simplest ways of identifying such individuals is to restrict the participants to right-handers" (p. 375).

In a study to investigate the influence of handedness on affective lateralization, Tan (2013) employs a DVF image-discrimination paradigm. In each condition, the participants are asked to decide whether the picture demonstrated on the visual field is emotional or neutral. In sum, better task performance was expected when stimuli were presented to individuals' dominant hemispheres. Tan found out that right-handers are expected to have improved the left hemisphere performance for emotional stimuli, and left-handers improved their right hemisphere performance for emotional stimuli.

However, DVF studies have also produced conflicting results. In a study conducted by Gainotti, Caltagironi, and Miceli (1984), they found that several people showed a left visual field advantage on a test of semantic discrimination of words matched with pictures. Thus, the participants appear to be right-brain dominant. However, Mishkin and Forgays (1952) found a right hemisphere advantage in visual word recognition. Hines, Satz, and Clementino (1973) also found better recall for digit sequences presented in the right visual half-field for right-handers.

2.4. Purpose and Research Question

Concerning what has been brought in the literature, the present study attempted to investigate whether there was any significant relationship between learners' language proficiency level and brain laterality. In the following study, the researchers using divided visual field (DVF) method endeavored to examine if there was any significant difference in the activity of the left and right side of the brain among individuals who have not been exposed to learning L2 and those who have been studying for the last 2 years. Henceforth, the following research question is raised.

Is there any significant relationship between Iranians' brain laterality and L2 language proficiency level?

3. Methodology

3.1. Participants

Participants included two groups of 15 learners studying at a popular language center located in the north of Iran, Bandar-e Anzali. The first group (7 males and 8 females) was selected from a subject pool of 90 learners. The very group was reported to be studying at the intermediate level; they have been studying in the very language center for about two years. The second group including 6 males and 9 females was randomly selected from a subject pool of 80 learners who has recently registered and had no considerable language experience. Moreover, the study was limited to the participants whose learning style was visual. Besides, to avoid anomalous data, the participants were restricted to the right-handed ones.

To make sure that the selected groups were homogenized on their language proficiency level, the present researchers made use of BABEL English Language Placement test. As a result, the first group was at the intermediate level, and the second group at the beginning level of language proficiency. The participants were all adults with their age ranging from 16 to 26, of both genders and of similar nationality.

3.2 Instrumentation and Materials

In the following research, the researchers made use of the following instruments and materials:

BABEL test. To become sure that participants were homogeneous, the researchers used BABEL test.

Barsch's Learning Style Inventory (LSI). To find out participants' learning style, the current study also used Barsch's (1980) Learning Style Inventory. LSI was used in order to identify whether the participants were visual, auditory, or kinesthetic learners.

The Edinburgh Handedness Inventory (Oldfield, 1971). To determine handedness, the researchers used the Edinburgh handedness inventory composed of 10 items. As reported by Dorthe, Blumenthal, Jason, and Lantz (1995), the very questionnaire is reported to have high test-retest reliability.

Tachistoscope. To determine participants' brain laterality, the researchers used a tachistoscope.

3.3. Data Collection and Analysis Procedures

The researchers first selected 68 language learners (36 females and 32 males) out of 90, based on the students' level of language proficiency from a well-known language center located in Iran. The participants were reported to have been placed at the intermediate level of proficiency. To ensure the homogeneity of learners, BABEL test was also employed.

The researchers have also selected 55 language learners (34 females and 21 males) out of 80, based on the students' language level of proficiency. The students were reported to be beginners studying at the very language center. To see if the participants were homogeneous, BABEL Test was used.

In so doing, the researchers, having distributed Barsch's (1980) Learning Style Inventory, examined the learners' learning style and finally selected the learners who had visual learning style and eliminated those who had auditory and/or kinesthetic learning styles. Later on, having employed the Edinburgh Handedness Inventory, the present researchers selected those students who were right-handed. In the end, 30 students (i.e., 15 beginners and 15 intermediates) were selected.

To determine the brain laterality, the researchers act as follows:

The DVF paradigm was conducted using a tachistoscope. The stimuli presented on the monitor of the tachistoscope were mainly lexical items in L2, presented in two separate horizontal lines. The words included *cat, dog, ant, rat, goat, duck, bear, and lion*, which were adequately screened in terms of word length, frequency, concreteness, imaginability, and number of phonemes.

To determine the participants' brain laterality, the researchers did as follows: having distributed the words in two lines, the subjects are allowed to recite them in 20 seconds:

(above words) *cat dog goat bear*
(below words) *rat ant duck lion*

To carry out the experiment, 90 times, each given word was presented in random order and visual field. Words were presented for 180 ms, with a fixation crosschair. The participants were instructed to maintain visual focus on the region of the screen where the fixation crosshair was placed, in order to maintain a divided visual field. Accordingly, when the above words were presented, either in the left or right visual fields, the participants were requested to push the H button of the key board, but when the below words were presented, they were going to push the G button. The same experiment was also done on a group of participants who has recently started learning an L2.

To make the participants familiar with the process of experiment, the researchers had presented earlier a preview of the stimuli prior to each condition; these previews were manually covered in an effort to reduce confounding. Specifically, it was done to prevent the use of memorization strategies, rather than affective appraisals, in the task. In sum, the practice round was presented first, and participants were free to repeat the round until they felt comfortable at performing the task. Immediately after the practice round, participants underwent both experimental conditions in the counterbalanced order.

In order to determine the dominant hemisphere, Banich (2003) suggests a simple formula. To Banich, the difference between performance in each visual field (RVF-LVF) divided by some measure of overall performance (RVF+LVF) provides a percentage measure of asymmetric performance of the items. In other words, if the report of an item is about 10% superior in the visual field, asymmetries will be proved. Significant asymmetries generally range from 20 milliseconds and up. In effect, by analyzing reaction time and judgment errors, brain functional laterality can be determined. Shorter reaction times and fewer judgment errors on the part of the related hemisphere are indicative that the given hemisphere is dominant (Alves, Fukusima, & Aznar-Casanova, 2008).

4. Results

Testing the Null Hypothesis

There is no significant relationship between brain laterality and individuals' language proficiency level.

To test the null hypothesis, a chi-square test was administered to investigate the possible relationship between EFL learners' language proficiency level and brain laterality. The results are shown in Table 4.1 and 4.2.

Table 4.1. The Relationship between Language Proficiency Level and Brain Laterality

Count	proficiency * laterality Cross tabulation			
		Brain laterality		Total
		left	Right	
Language proficiency level	intermediate	1	14	15
	beginner	13	2	15
Total		14	16	30

Table 4.1 displays that out of 30 participants, sixteen intermediate participants had right dominant cerebral hemisphere. Moreover, it also showed that the majority of the participants who were beginners were left-brained d (N= 14). In comparison, most of the intermediate participants had right brain dominance (N= 14). This suggested that most participants with right-brain dominance were among intermediates.

Table 4.2. Chi- Square Test for the Relationship between Language Proficiency Level and Brain Laterality

	Value	Df	Asymp.Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	19.286	1	.000		
Fisher's Exact Test				.000	.000
N of Valid Cases	30				

Since a 2 by 2 table was used to examine the possible relationship between language proficiency levels (beginners and intermediate) and brain laterality (right and left), Fisher's Exact Probability Test with an associated significance level of .000 was reported. In addition, the two-sided asymptotic significance of the chi-square statistic for the participants' foreign language proficiency and their brain laterality was lower than (0.05), so it could be concluded that the relationship between these two variables was not due to chance variation, which implied that each participant with specific foreign language proficiency level had different brain laterality. This meant that the proportion of intermediates that were right-brained was significantly different from the proportion of beginners who had left brain dominance. Consequently, there appeared to be a significant association between foreign language proficiency and brain laterality. To show the strength and direction of this relationship, Phi and Cramer's V test was also run.

Table 4.3. Symmetric Measures for the Relationship between Language Proficiency Level and Brain Laterality

		Value	Approx. Sig.
Nominal by Nominal	Phi	.802	.000
	Cramer's V	.802	.000
N of Valid Cases		30	

Based on the results of Phi and Cramer's V, there appeared to be a significant association between foreign language proficiency and brain laterality. The value of Phi came to (.802; sig. (.000) $\leq$.05). Thus, the null hypothesis, stating that there is a relationship between foreign language proficiency level and brain laterality, was rejected.

5. Conclusion and Discussion

Streams of research provide us with information about the brain of bilinguals and monolinguals. Previous studies of SLA are coupled with speculations. There is a variety of hypotheses regarding the influence of language experience on cerebral lateralization. Two early hypotheses are *second language hypothesis* raised by Genesee (1982) and Galloway and Krashen's (1978) *balanced bilingual hypothesis*. To Genesee (1982), bilinguals show greater right hemisphere involvement in language experience. In contrast, Galloway and Krashen (1978) assert that less proficient bilinguals are less right hemisphere lateralized than monolinguals. Conversely, stage hypothesis suggested by Obler, Albert, and Gordon (1975) maintains that language proficiency has a significant effect on brain laterality. That is, bilinguals are initially dependent on the right hemisphere, but with an increase in L2 proficiency, they become more left-hemisphere lateralized.

To conclude, the current research findings differ from those proposed by Albert and Obler (1978). To them, with an increase in language proficiency, the right hemispheric dominance gets less dominant. To Albert and Obler, bilinguals were less hemispheric dominant than monolinguals. Conversely, to several scholars (e.g., Albanese, 1985), proficiency in L2 increases the dominance of the right hemisphere. In effect, the findings of the present work are compatible with the scholars (e.g., Albanese, 1985; Kasaeeian, 1993) whose studies on the brain have indicated that more activation on the right hemisphere is resulted from the proficiency in L2.

The implications of neuroscience for SLA can clearly be seen in the following category, that is, the brain laterality. Scholars (e.g., Piaw, 2011; Springer & Deutsch, 1993) assert that when people are thinking or learning, they prefer to rely on either the left or the right brain. Accordingly, Sperry (1981) holds that different hemispheres are responsible for different learning tasks. The left hemisphere is accountable for an analytical, logical, and linear approach to problems, while the right hemisphere is concerned with intuitive, synthesist and non-linear approaches. Thus, the investigation of the left and right brain dominants helps the teachers and curriculum designers with the choice of the topics used for the four language skills: reading, speaking, writing, and listening. In fact, interesting topics provide a stimulus that transmits the impulse to thalamus which leads to a map formation in the hippocampus (Sylwester, 1995). However, future studies with larger samples and improved imaging and analysis techniques are expected to investigate whether the two hemispheres accountable for different learning tasks can contribute to the language proficiency.

References

Abbuhl, R. (2012). Why, when, and how to replicate research. In A. Mackey & S. M. Gass, *Research methods in second language acquisition: A practical guide* (pp. 296-312). London: Wiley & Blackwell.

Albanese, J. F. (1985). Language lateralization in English French Bilinguals. *Brain and Language, 24*, 284-296.

Albert, M., & Obler, L. (1978). *The bilingual brain: Neuropsychological and neurolinguistic aspects of bilingualism.* New York: Academic Press.

Alves, N. T., Fukusima, S. S., & Aznar-Casanova, J. A. (2008). Models of brain asymmetry in emotional processing. *Psychology and Neuroscience, 1*(1), 63-66.

Appel, R., & Muysken, P. (1987). *Language contact and bilingualism.* London: Edward Arnold.

Banich, M. T. (2003). The divided visual technique in laterality and interhemispheric integration. In K. Hugdahl (Ed.), *Experimental methods in neuropsychology* (pp. 47-64). New York: Springer Science Business Media, LLC.

Banich, M. T., & Shenker, J. I. (1994). Investigations of interhemispheric processing: Methodological considerations. *Neuropsychology, 8*, 263-277.

Barsch, J. (1980). Barsch learning style inventory. Retrieved from http://windward. Hawaii edu /trio/forms/participant_inventories.pdf.

Beauchet, O. (2006). Testosterone and cognitive function: current clinical evidence of a relationship. *European Journal of Endocrinology, 155*, 773-781.

Beaumont, J. G. (1982). *Divided visual field studies of cerebral organization*. New York: Academic Press.

Birjandi, P., & Seyyedrezaei, S. H. (2012). Left or right hemisphere? A novel answer to the old question of lateralization by introducing IRL (Individualistic Relativistic Lateralization). Theory and Practice in Language Studies, 2(8), 1762-1766. doi:10.4304/tpls.2.8

Boeree, C. G. (2004). Speech and the brain. Retrieved from http:// webspace. ship.edu /cgboer /speech brain.html

Bourne, V. J. (2006). The divided visual field paradigm: Methodological consideration. Laterality, 11(4), 373-393.

Burman, L. E., Reed, W. R., & Alm, J. (2010). A call for replication studies. Public Finance Review, 38(6), 787-793. doi. 10.1177/1091142110385210

Caplan, D. (1995). Language and the brain. *The Harvard Mahoney Neuroscience Institute Letter on the Brain, 4*(4), 302-313.

Diamond, S., & Beaumont, G. (1972). Processing in perceptual integration between the cerebral hemispheres. *British Journal of Psychology, 63*, 509 –514.

Dorthe, N. J., Blumenthal, T. D., Jason, D. R., & Lantz, P. E. (1995). The use of next-of-kin in assessing handedness. *Percept Mot Skills, 81*(1), 203-208.

Faruji, L. F. (2011). Neurolinguistics aspects of second language acquisition. *Brain: Broad Research in Artificial Intelligence and Neuroscience, 2*(4), 36-40.

Gainotti, G., Caltagironi, C., & Miceli, C. (1983). Selective impairment of semantic lexical discrimination in right brain damaged patients. In E. Perecman (Ed.), *Cognitive processing in the right hemisphere* (pp. 149-167). New York: Academic Press

Galloway, L., & Krashen, S. (1978). *Cerebral organization in bilingualism and second language.* Paper Presented at the Second Language Research Forum, USO.

Genesee, F. (1982). Experimental neuropsychological research on second language processing. *TESOL Quarterly, 16*, 315-321.

Grosjean, F. (1989). Neurologists beware! The bilingual is not two monolinguals in one person. *Brain and Language*, *36*, 3-5.

Gur, R. C., Alsop, D., Glahn, D., Petty, R., Swanson, G. L., Maldjian, J. A., Turetsky, B. I., Detre, J. A., Gee, J. & Gur, R. E. (2000). An fMRI study of sex differences in regional activation to a verbal and a spatial task. *Brain and Language, 74(2)*, 157–170.

Hines, D., Satz, P., & Clementino, T. (1973). Perceptual and memory components of the superior recall of letters from the right visual half-fields. *Neuropsychologia*, *11*(2), 175-180.

Jensen, E. (2000). *Brain-based learning*. California: Corwin Press.

Kasaeeian, Z. (1993). A study on brain laterality among English-Persian bilinguals. *Applied Sociology, 5,* 67-76.

Magon, A. J. (2009). Gender, the brain and education: Do boys and girls learn differently? (Unpublished Master's thesis). Amsterdam University, Amsterdam. Retrieved in 2012 from http://dspace.library. uvic.ca:8080/bitstream.

Mishkin, M., & Forgays, D. G. (1952). Word recognition as a function of retinal locus. Journal of Experimental Psychology, 43, 43-48.

Obler, L. (1981). Right hemisphere participation in second language acquisition. In K. Diller (Ed.), Individual differences and universals in language learning aptitude (pp. 53-64). Rowley: Newbury House.

Obler, L. K., Albert, M. L., & Gordon, H. W. (1975). Asymmetrical cerebral dominance in bilinguals. Paper presented at the academy of aphasia. Victoria, Canada.

Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. Neuropsychologia, 9(1), 97-113.

Paradis, M. (1990). Language lateralization in bilinguals: Enough already! Brain and Language, 39, 576–586.

Paradis, M. (2000）. The neurolinguistics of bilingualism in the next decades. Brain and Language, 71, 178-180.

Piaw, C. Y. (2011)***. Brain hemisphericity and language learning style of the Malaysian Chinese.*** Retrieved from http://repository.um.edu. my/id/eprint/10199.

Poffenberger, A. (1912). Reaction time to retinal stimulation with special reference to the time lost in conduction through nervous centers. *Archives of Psychology, 23,* 1-73.

Pujol, J., Deus, J., Losilla, J. M., & Capdevila, A. (1999). Cerebral lateralization of language in normal left-handed people studied by functional MRI. *Neurology, 52*(5), 1038-1043.

Pulvermiiller, E, & Mohr, B. (1996). The concept of transcortical cell assemblies: A key to the understanding of cortical lateralization and interhemispheric interaction. *Neuroscience & Biobehavioral Reviews 20*(4), 557-566.

Ross, E. D., & Monnot, M. (2008). Neurology of affective prosody and its functional-anatomic organization in right hemisphere. *Brain Lang, 104* (1), 51–74. doi:10.1016/ j.bandl.2007. 04.007. PMID 17537499.

Schmidt, S. (2009). Shall we really do it again? The powerful concept of replication is neglected in the social sciences. *Review of General Psychology, 13*, 90–100.

Shanon, B. (1982). Lateralization effects in the perception of Hebrew and English words. *Brain and Language*, *17*, 107-123.

Sperry, R. (1981). Some effects of disconnecting the cerebral hemispheres. Retrieved from http://people.uncw.edu/puente/sperry/sperrypapers/80s

Springer, S. P., & Deutsch, G. (1993). Left brain, right brain. New York: W. H. Freeman & Company.

Sylwester, R. (1995). *A celebration of neurons*. Virginia: Association for Supervision and Curriculum Development.

Tan, K. A. M. (2013). Effects of handedness on affective lateralization: a divided visual-field study. Retrieved from www.andrew.cmu. edu/.../(2013 %20 Tan)%20.

Voyger, D. (1996). On the magnetic laterality effects and sex differences in functional lateralities. *Laterality, 1*(1), 51-83.

Wagner, A. D., Schacter, D.L., Rotte, M., Koutstaal, W., Maril, A., Dale, A.M., Rosen, B. R., & Buckner, R. L. (1998). Building memories: Remembering and forgetting of verbal experiences as predicted by brain activity. *Science, 281*, 1188–1190.