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The Multidimensional Connection between Second Language Acquisition and Neuroscience

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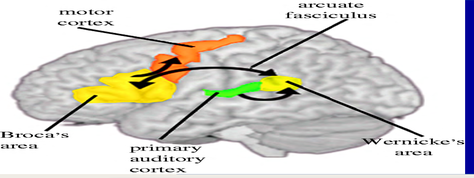

The Multidimensional Connection between Second Language Acquisition and Neuroscience: The Complex Relationship between Brain Hemispheric Involvement and Impact on Second Language Development

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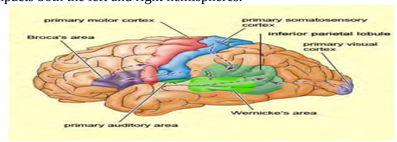
ABSTRACT

Introduction: Second language acquisition during adolescence through adulthood is significantly impacted by structures in both the right and left hemispheres that process language. An individual's degree of proficiency in his or her first language (L1) greatly determines one's ability to learn and demonstrate proficiency in the second language (L2). Neurological, medical imaging studies such as *functional and structural magnetic resonance imaging*, *electroencephalography, voxel-based morphometry, and electromyography* provide essential information about hemispheric changes in the brain regarding the language processing regions. Educators can use the information provided in these imaging studies to enhance their practice when working with adolescent and adult English learners; understanding that both the right and left hemispheres are involved during language processing, will better assist educators in providing strategies that will best meet their students' needs during L2 development. **Methodology:** I divided my research into three topics: *neurological imaging used to determine hemispheric involvement*, *the role of the right and left hemispheres in L2 language development*, and *educational implications*. The purpose of this research was to collect and discuss the current body of literature regarding the connection between neuroscience and second language acquisition, particularly learning a second language during adolescence-adulthood. Most of the research has used clinical neurological imaging as the foundational design to determine the involvement and degree of bilateral hemispheric involvement. My research analyzes the clinical neuroscience and explores the integral role that neurological imaging serves in analyzing bilateral hemispheric involvement; further information is provided regarding the impact on second language acquisition in adolescents and adults. The clinical outcomes indicate defined brain structures involved in L2 language development. **Results: C**linical neurological imaging and hemispheric involvement serve an integral role in second language acquisition in adolescents and adults. Educators can acquire knowledge of how the neurological information impacts academic performance ; strategies can be developed and implemented to teach adolescent and adult English language learners. **Discussion:** The relationship between neurological imaging, right and left hemispheric involvement, and educational implications are integral to second language acquisition. **Each area serves a vital role in an adolescent and adult's English language development; therefore, second language acquisition is a complex, multifaceted process that impacts adolescent and adult English learners in regards to academic performance, English vocabulary development, and communication in English via reading, writing, speaking, and listening. Understanding the relationship between neurological imaging, hemispheric involvement, and educational implications allows for development and implementation of strategies in the classroom to best meet the needs of adolescent and adult English learners.**

INTRODUCTION

SECOND LANGUAGE ACQUISITION DURING ADOLESCENCE AND ADULTHOOD

Clinical neurological imaging indicates that the language processing centers in both the right and left hemispheres in the brain have proven to be activated during an individual's study of a second language. Second language vocabulary development during adolescence and adulthood indicates that the brain's grey matter impacts both the left and right hemispheres.



SIGNIFICANCE

- Positive correlation between neuroscience and second language acquisition during adolescence and adulthood
- Vocabulary learning in L2 (English) greatly depends on L1 vocabulary lexicon
- L2 development and proficiency is impacted by *age of acquisition*, and *socioeconomic status*
- Educators can use this research to develop and implement instructional practices when teaching adolescent and adult English language learners.
  - An integral relationship is shown between clinical neurological imaging, hemispheric involvement, and educational implications

GOAL AND RATIONALE

GOAL

- To present and analyze literature that addresses second language acquisition among adolescent and adult English language learners that answers the question , what does the current body of research say about the impact of neuroscience on second language acquisition for adolescent and adult learners between 2009-2017?

RATIONALE

- Clinical neuroscience and second language acquisition among adolescents and adults demonstrates a strong, positive correlative relationship. The language processing centers in both the right and left hemispheres in the brain have proven to be activated during an individual's study of a second language. Second language vocabulary development during adolescence and adulthood indicates that the brain's grey matter impacts both the left and right hemispheres; therefore, second language acquisition is a highly complex process that involves several critical features that must align in order for successful learning of and ultimately mastering, a second language.

- The neurological imaging illuminates the exact region(s) of the brain that impact second language development. Therefore, the imaging provides critical insight into vocabulary development ; in adolescent and adult English learners, L2 vocabulary is learned through proficiency and language development in L1. Understanding how neuroscience explains the inner-working of second language acquisition, provides key information about how adolescent and adult English learners acquire a second language. The relationship between neuroscience and second language development is, therefore, multifaceted and complex.

METHODOLOGY

TOPIC 1: NEUROLOGICAL IMAGING USED TO DETERMINE HEMISPHERIC INVOLVEMENT

Diagnostic Neurological Imaging Studies:

- ***Functional Magnetic Resonance Imaging (fMRI)***
- ***Structural Magnetic Resonance Imaging (MRI)***
- ***Voxel-based Morphometry (VBM)***
- ***Electromyography (EMG)***
- ***Encephalography (EEG)***

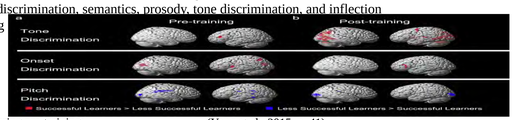
- Perception of L2 sounds is impacted by left insula/prefrontal cortex, left temporal lobe, and bilateral regions of the parietal lob
- Increased activation in the *superior temporal gyrus*, *bilateral posterior middle temporal gyrus* and *angular gyrus*, *fronto-parietal (central)*
- Right hemisphere: Morphological processing of L2; English inflection is learned bilaterally
- Bilateral Involvement: pitch discrimination, semantic processing, tone discrimination, and prosodic learning and processing
- L2 words are less emotionally involved than L1
- Increased density of gray matter in multilingual speakers vs. bilingual speakers
- Bilingual speakers showed positive correlation between grey matter in the inferior frontal lobe and second language lexical efficiency.

TOPIC 2: THE ROLE OF THE RIGHT AND LEFT HEMISPHERES IN L2 LANGUAGE DEVELOPMENT

- L2 Vocabulary: Bilateral involvement is shown in *front-subcortical-parietotemporal* areas, mostly in the right hemisphere
- Bilingual patients demonstrated *increased activation in right hemisphere*
- Monolingual speakers *showed left hemispheric lateralization*

TOPIC 3: EDUCATIONAL IMPLICATIONS

- **Utilization of clinical neuroscience research when teaching:**
- Language features: Pitch discrimination, semantics, prosody, tone discrimination, and inflection
- Reading, writing, speaking

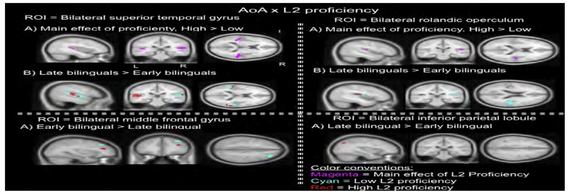


This **fMRI study** indicates that during pre-training: (Yang et al., 2015, p. 41)

- The *left superior temporal gyrus* serves an integral role during phonological processing of lexical tones
- Learners showed smaller neural differences in **tone discrimination** (*left middle frontal gyrus*)
- Learners showed greater activation in *left superior temporal gyrus*, *left superior parietal lobe*, *precuneus*, and *cuneus* during **onset discrimination**
- Learners showed increased activation in *left inferior frontal gyrus*, *right superior temporal gyrus*, *right inferior parietal lobe* and *left fusiform gyrus* during **pitch discrimination**

RESULTS

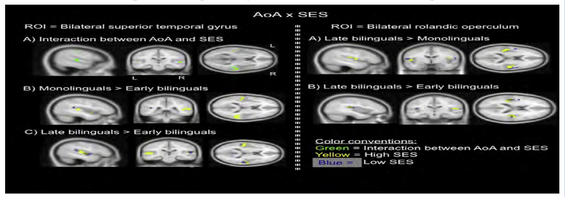
Figure 1: ***Age of Acquisition x L2 Proficiency***
Bilateral Superior Temporal Gyrus, Bilateral Rolandic Operculum, Bilateral Middle Frontal Gyrus, and Bilateral Inferior Parietal Lobule



(Archila-Suerte et al., 2015, p. 44)

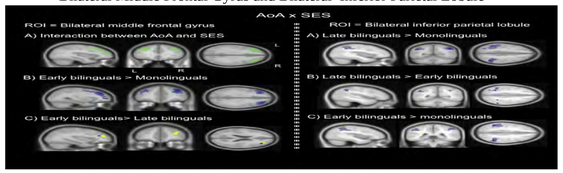
- This fMRI study illustrates the relationship between an individual's age of second language acquisition and second language proficiency.
- Imaging results indicate that late bilingual and monolingual speakers, who had equal socioeconomic status, demonstrated increased activation in the *superior temporal gyrus*

Figure 2A: ***Age of Acquisition and Socioeconomic Status***
Bilateral Superior Temporal Gyrus and Bilateral Rolandic Operculum



(Archila-Suerte et al., 2015, p. 43)

Figure 2B : ***Age of Acquisition and Socioeconomic Status***
Bilateral Middle Frontal Gyrus and Bilateral Inferior Parietal Lobule



(Archila-Suerte et al., 2015, p. 43)

- **Figures 2A and 2B illustrate**:
- involved brain regions during early bilinguals and late bilinguals of same socioeconomic status
- *English syllables vs. baseline*
- Differences in socioeducational status might impact L2 oral and receptive proficiency

DISCUSSION

Relationship between Neurological Imaging and Educational Implications

- Educators can better individualize ESL students' instruction and provide targeted language instruction when provided clinical neurological information regarding *age of acquisition*, *socioeconomic status*, and *second language proficiency*
- Educators can refer the research discussing *pitch discrimination, semantics, prosody, tone discrimination, and inflection* to assist their bilingual students in learning these language features as they pertain to English.
- Educators can use the research explaining acquisition of L2 vocabulary when teaching English and the connection to the right hemisphere.

Relationship between Hemispheric Involvement and Educational Implications

- Language learning: bilateral involvement
- Reading and Vocabulary: increased L2 vocabulary affords greater gains in word learning

Integration between Clinical Neuroscience Imaging, Hemispheric Involvement, and Educational Implications

- Defined relationship between *the age of second language acquisition, socioeconomic status, and proficiency in L1* when striving to learn L2.
- Integral relationship between language processing regions and L2 during adolescence-adulthood
- Bilateral lateralization of the brain
  - **Right:** *bilingual* activation
  - **Left:** *monolingual* activation

KEY REFERENCES

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