# Application Of Herrmann's Brain Quadrant Model and its Relationship with Learning Styles in Anesthesiology Residents

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## *Abstract*

**Background:** In the field of medicine, the ability to learn and adapt to clinical demands is essential in the training of residents. The Herrmann Brain Model categorizes thinking styles based on the preference for utilizing brain quadrants, serving as an applied tool for residents to assess their learning preferences.

**Objective:** This study aims to delineate the learning styles according to Herrmann's brain quadrant model among anesthesiology residents at the Hospital de Especialidades de Centro Médico Nacional de Occidente.

**Methods:** A cross-sectional descriptive study was conducted. Anesthesiology residents were enrolled, and the Herrmann Brain Dominance Test was administered. Each brain quadrant embodies distinct characteristics, thinking patterns, and approaches to knowledge acquisition. The test comprises 120 multiple-choice items on academic, daily, and professional scenarios. The quadrants are described as follows: LC "Scientific Expert," LL "Organizer-Introvert," RC "Interpersonal Strategist," RL "Imaginative Communicator."

**Results:** Twenty-seven residents participated, with an average age of 28.4 ± 1.4 years (12 [44.4%] female and 15 [55.5%] male). According to the dominance test, the predominant cerebral hemisphere was quadrant LC in 8 residents (29.6%), 6 with LC/RC (22.2%), 6 with LC/LL (22.2%), 3 with CD (11.1%), 2 with LL (7.4%), and 1 with LL/RC (3.7%). One case exhibited no dominance, represented graphically as "None" (3.7%).

**Conclusions:** Utilizing this model among residents revealed that the left cortical quadrant, designated as the "scientific expert," exhibited the highest dominance. A logical, analytical, and rational personality characterizes this quadrant. Clinical Trial: R-2023-1301-136.

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# Original Manuscript

**Original Article**

# Application Of Herrmann's Brain Quadrant Model and its Relationship with Learning Styles in Anesthesiology Residents

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**Abstract**

**Background**: In the field of medicine, the ability to learn and adapt to clinical demands is essential in the training of residents. The Herrmann Brain Model categorizes thinking styles based on the preference for utilizing brain quadrants, serving as an applied tool for residents to assess their learning preferences.

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**Results:** Twenty-seven residents participated, with an average age of 28.4 ± 1.4 years (12 [44.4%] female and 15 [55.5%] male). According to the dominance test, the predominant

cerebral hemisphere was quadrant LC in 8 residents (29.6%), 6 with LC/RC (22.2%), 6 with LC/LL (22.2%), 3 with CD (11.1%), 2 with LL (7.4%), and 1 with LL/RC (3.7%). One case exhibited no dominance, represented graphically as "None" (3.7%).
**Conclusion:** Utilizing this model among residents revealed that the left cortical quadrant, designated as the "scientific expert," exhibited the highest dominance. A logical, analytical, and rational personality characterizes this quadrant.
**Keywords:** Residency, Learning, Herrmann´s Model, Medical Knowledge, Cognitive Function

## Background

In life learning and experience are in conjunction with sensory information, which becomes important in behavior, and affects perception, cognition, and action [1]. The main part of learning and memory is "plasticity", this refers to changes in the strength of synapses or the intrinsic excitability of a neuron's membrane [2, 3]. The cerebellum, parietal lobe, and somatosensory areas are related to kinesthetic-type learning. The temporal lobe is related to language production and comprehension, auditory learning. The visual cortex and occipital cortex are related to visual learning [4].
When we talk about learning and learning styles, it is important to mention that learning is carried in the cerebral cortex by various brain systems, such as memory. Working memory is an executive process that stores, maintains, and manipulates relevant information, these processes can be grouped into three
phases; encoding, maintenance, and retrieval of information. Key centers have been identified for different types of associative memory, with the hippocampus involved in episodic memory, the striatum involved in stimulus-response learning, and the amygdala involved in classical conditioning [5–8].
Associative learning can modify the activity of numerous neurons which are distributed in cortical and subcortical regions. In contrast, individual neurons modify the frequency or rate of spike patterns in response to environmental stimuli as they are associated with important outcomes [9, 10].
There are numerous tests of memory types, in which reference is made to the corresponding brain regions. Memory-related regulatory brain regions are not functionally homogeneous but have subregions with different firing patterns and connectivity profiles, which may support different types of memory [11].
Our study aims to deeply probe and analyze learning styles in anesthesiology residents with the Herrmann Brain Dominance Instrument (HBDI) model, to compare learning styles and their relationship to the dominant brain hemisphere based on 120 items, of which the results are grouped in relative order of dominance of thinking, learning manner, communication and decision making [12].

## Material and methods

### Design and Study

A descriptive cross-sectional study was carried out, in which anesthesiology residents of the Hospital de Especialidades del Centro Médico Nacional de Occidente del Instituto Mexicano del Seguro Social were included.

### Selection of the Study Population

The study included physicians between 27 and 32 years of age of both genders to whom the Herrmann cerebral dominance test was applied during the period January 1 to December 31, 2023.

### Measurement Instruments and Technique

All residents completed the survey before consent approval. All information was integrated into a data source for processing and analysis. The Herrmann brain dominance test, created by Ned Herrmann, consists of 120 questions designed to evaluate individual preferences in information and thought processing [12]. These are multiple-choice items with 4 possible answers (A, B, C, D) associated with everyday, academic, and work situations, to explore how each person approaches different situations and problems and to what extent he/she tends to use each of the four proposed brain quadrants. This model does not fit into only one quadrant; it can include single, double, triple, or quadruple dominance.
The result was evaluated by quantifying the number of times a specific quadrant is chosen and the result is multiplied by 20; a result greater than 66 means that there is a preference for a specific quadrant, thus indicating the dominant quadrant, whereas if the result is less than 33 points there is no preference for the quadrant, and a score between 33 and 66 indicates an intermediate preference. The brain quadrants in this test are described as; Left Cortical (LC) "The Expert-Scientist", Left Limbic (LL) "The Organizer- Introvert", Right Cortical (RC) "The Strategist Interpersonal", Right Limbic (RL) "Communicator-Imaginative". The final result of the test provides a visual representation of each person's thinking preferences, showing the extent to which he or she tends to use each of the quadrants that identify the four main cognitive processing areas in the brain.
All residents completed the survey before consent approval. All the information was integrated into a data source for processing and analysis.

**Statistical Analysis**

A data analysis was performed using the Epi-Info 7.2.4 program. The results were expressed in frequencies and percentages for qualitative variables; averages and standard deviations for quantitative variables.

## Results

Twenty-seven anesthesiology residents were studied. 12 were female (44.4%) and 15 were male (55.5%).
Ages ranged from 27 to 32 years, with a mean of 28.4 ± 1.4 years. Figure 1 shows the results of the Herrmann test surveys.
Of the total population, 8 (29.6%) residents showed left cortical quadrant dominance, 6 (22.2%) with double cortical dominance (left cortical quadrant with right cortical), and 6 (22.2%) with double left hemisphere dominance (left cortical with left limbic). The rest of the quadrants were less frequent, occurring in 3 (11.1%) with right cortical, 2 (7.4%) with left limbic, 1 (3.7%) with contralateral double dominance (left limbic with right cortical), finally, there was a case without dominance, where there was no high preference for any quadrant, but there was an average preference for the four quadrants equally, this case was plotted as "None" (3.7%). Table 1
Table 2 shows an equal predominance of single and double dominance, found in 13 (48.1%) residents each, and with a lower frequency of no dominance (3.7%).
Table 3 shows the double dominance profiles, with an equal predominance of the left hemisphere and cortical in 6 (46.1%) of each and 1 (7.7%) in contralateral dominance (RC/ LL).
A predominance of the LC quadrant is shown in the female sex with 5 (18.5%), in the male sex in 3 (11.1%), the LC/RC cortical double dominance in the female sex in 2 (7.4%), in the male sex in 4 (14.8%), the RC quadrant represents in female sex in 2 (7.In the male sex, the left limbic in 2 (7.4%), the left hemisphere double dominance (LC/LL) in 1 (3.7%) female sex, 5 (18.5%) in male sex, the LL/RC dominance in 1 (3.7%) of female sex. One case was found in the male sex with a preference for no dominance (3.7%).
There was a predominance of the left cortical quadrant in 8 (29.6%), 5 (18.5%) of which

were female.
The male sex showed a preference for double dominance of the left hemisphere in 5 (18.5%). This is summarized in Figure 2.

## Discussion

This article included residents of the specialty of anesthesiology who were evaluated with the Herrmann brain quadrant test to determine the learning style of each one of them based on the predominant cerebral hemisphere, as mentioned by Luc Rousseau and Torrijos-Muelas in their respective studies, knowing which hemisphere is most used by people helps to understand the individual differences in each learning process [13, 14].
In the population study, it was found that the quadrant with the greatest predominance was the left cortical (30%), with greater dominance in the female sex in the third year, which speaks of rational people, who prefer teaching based on evidence and facts before experimentation. The research by Iqbal Hydrie and Lundell Rudberg, which discusses the study preference of medical and nursing students, based on Kolbs' method, indicates that most of the participants had a preference for divergent learning, which tends to be concrete and reflective, so we can compare the relationship between the two studies, finding a similarity between the use of the left hemisphere and the preference for learning based on an environment where reflection can take place before it is carried out; however, our study did not find a significant difference in terms of the sex of the participants, since there was a male predominance [15, 16].
The double dominance of the left hemisphere (left cortical and left limbic) was the second most predominant, representing 22%, which has a fusion in the preference for rational and organized learning. According to the studies carried out by Sohrabi, Sha,ik, and Olsson, they mention that the "accommodative" style is largely found in medical students, in agreement with what was described above. It also mentions that those pigeonholed in this style tend to be concrete and active, in this hemisphere [17–19].
In third place was found the double cortical dominance (left cortical and right cortical) at 22%, placing them within the rational and experiential category. Czepula and Wong talk in their study about Honey-Mumford's learning styles; which are classified into active, reflective, theoretical, and pragmatic. Both mentioned that the majority of their study population was categorized as pragmatists, described as people who manage to discover strategies and verify if these are efficient and valid. These are related to the result found in our sample, where only 22% of the pragmatic category was reported, differing from that reported in Wong's study [20, 21].
Comparing the years of residence and the dominant hemispheres, a significant difference was found: in the 3rd year residents, both the left cortical and the double dominance of the left hemisphere were found in equal percentages, while the 2nd year residents presented more on the cortical side (LC/RC). This tells us about a preference for rational and organized learning in the older generation, while in the younger generation, there was a preference for rational and experimental learning. Hu and Xu, in their studies, mention that learning styles are influenced by the environment and discipline of the students, which can vary between generations, even when the same thing is being studied, so we can conclude that the difference in learning styles in residents of different generations makes sense [22, 23].
Regarding the chosen study model, it was possible to differentiate the cerebral quadrants based on their character, their way of thinking, and how knowledge is acquired individually.
Our study is limited by the small size of the population studied, which prevents a significant comparison between age and sex, as well as the frequency of the predominant quadrant depending on the generation of residence. While not relevant to our study, this information may be valuable for future research.

Our study is unique as it focuses on a specific population. We have discovered a connection between dominant hemispheres and learning styles, particularly concerning medical specialty training. This provides valuable insights into how this particular group learns. As a result of our findings, we have developed tools to enhance the learning process.

## Conclusions

Our study shows that the quadrant with the highest dominance in the population studied was the left cortical, similar to what is mentioned in the literature; medical students have a preference for the left hemisphere, in addition to the coincidence with the character of people with such dominance with that of our respondents.
We were able to demonstrate that the learning style and the dominant hemisphere go hand in hand; allowing the creation of a strategy to improve learning, as well as how to transmit learning to residents with better tools, making it easier to transmit and receive learning.

## Declarations

**Ethical Aspects:** The study was conducted under the principles of the 2013 Declaration of Helsinki and its amendments, and the Mexican Health Guidelines. The Ethics and Research Committees of the Hospital de Especialidades approved the protocol under the registration number R-2023-1301-136.
All residents completed the survey before consent approval. The authors obtained the written authorization of each participant, and the surveys were anonymous to ensure confidentiality.
The protocol was approved by the Local Health Research and Ethics Committee under registration number 2022/1356. We submitted the study protocol to ClinicalTrials.gov and it was registered under the number NCT06479044 ||https://www.clinicaltrials.gov/) with the Clinical Trial Registry ({06/26/2024}).

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**Data Availability Statement**: The data that support the findings of this study are available upon reasonable request from the corresponding author.
**Conflicts of Interest:** none declared.

***Author Contributions Statement.***

A.O.B.: design of the work, analysis, wrote the main manuscript text

P.A.A.G.: design of the work, wrote the main manuscript text

A.G.O.: analysis, interpretation of data

A.G.T.G: design of the work, analysis, interpretation of data, wrote the main manuscript text

S.J.V.S.: design of the work, analysis, interpretation of data, wrote the main manuscript text

S.E.G.M: design of the work, analysis, wrote the main manuscript text
G.R.: design of the work, interpretation of data

A.G.: analysis, interpretation of data

A.G.S.L.: interpretation of data

K.D.M.M.: interpretation of data

G.C.G.: design of the work, analysis, interpretation of data

E.C.P.: analysis

S.R.O.: analysis

A.O.C.F.: analysis

M.C.T.: analysis

C. F. O.: design of the work, analysis, interpretation of data

All authors reviewed the manuscript

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**Tables**

**Table 1.** Number of residents and percentage of dominant quadrants.

| Dominant Quadrant | Number of residents | Percentage of dominance |
|---|---|---|
| LC | 8 | 29.6% |
| RC | 3 | 11.1% |
| LL | 2 | 7.4% |
| RL | 0 | 0% |
| LC/RC | 6 | 22.2% |
| LC/LL | 6 | 22.2% |
| RC/LL | 1 | 2.7% |
| NO DOMINANCE | 1 | 3.7% |
| Total | 27 | 100% |

LC: Left Cortical, RC: Right Cortical, LL: Left Limbic, RL: Right Limbic, L C/RC: double

dominance Left Cortical /Right Cortical, L C/LL: Double dominance Left Cortical/Left Limbic, RC/LL: Double dominance Right Cortical /Left Limbic.

**Table 2.** First cerebral dominance in the residents of the study population.

| Types of dominance | Number of residents | Percentage |
|---|---|---|
| Simple Dominance | 13 | 48.1% |
| Double Dominance | 13 | 48.1% |
| No Dominance | 1 | 3.70% |
| Total | 27 | 100% |

The types of dominance in the residents are shown in percentages.

**Table 3.** Double Dominance Profile in the residents of the study population.

| Double dominance profile | Number of residents | Percentage |
|---|---|---|
| Left Hemisphere (LC/LL) | 6 | 46.1% |
| Right Hemisphere (RC/RL) | 0 | 0% |
| Cortical (LC/RC) | 6 | 46.1% |
| Limbic (LL/RL) | 0 | 0% |
| Contralaterals (LC/RL) | 0 | 0% |
| Contralateral (RC/LL) | 1 | 7.7% |
| Total | 13 | 100% |

**Figures**

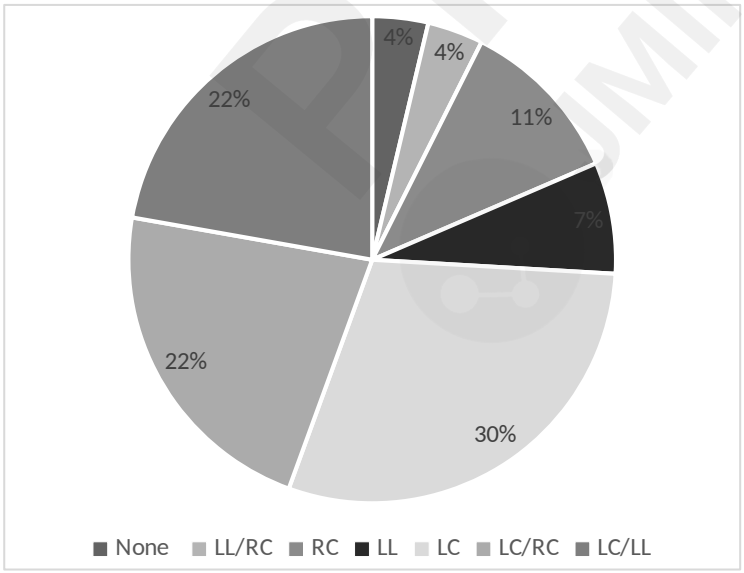


**Figure 1**
Frequency of Cerebral Dominance in the residents of the study population.

LL/RC: left limbic/right cortical, RC: right cortical, LL: left limbic, LC: left cortical, LC/RC: left

cortical/right cortical, LC/LL: left cortical, left limbic

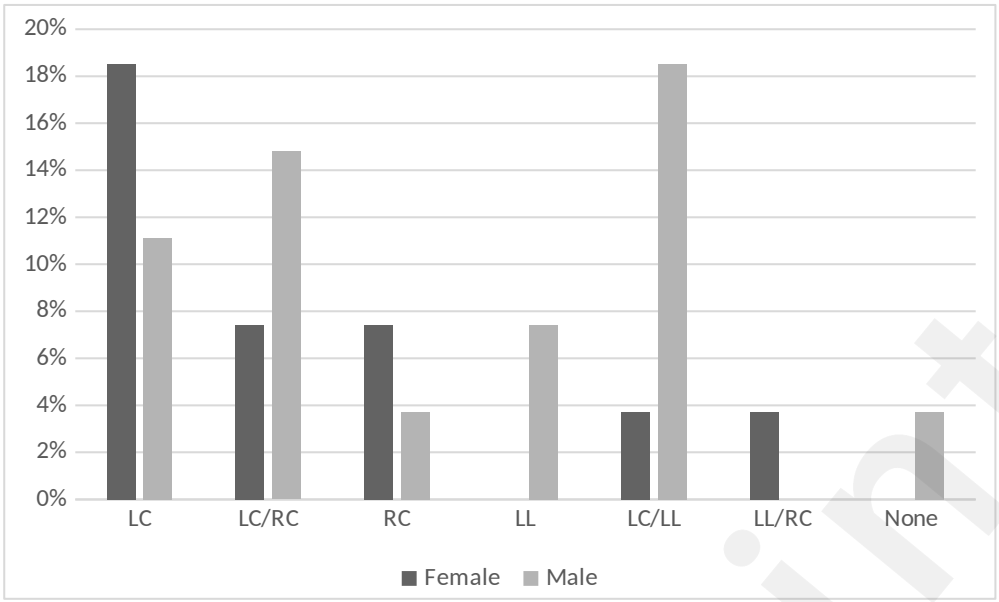


**Figure 2**
Percentage of dominance in relation to sex.

LC: Left Cortical, L C/RC: Left cortical/Right Cortical, CD: Right Cortical, LL: Left Limbic, L C/LL: Left Cortical/ Left Limbic, LL/RC: Left Limbic/ Right Cortical

# Supplementary Files

# Figures

Untitled.