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Cerebral Hemispheres and Learning: A Study of the Correlation between Brain Dominations and Learning Styles

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Abstract—Brain consists of left and right cerebral hemispheres. Left cerebral hemisphere controls right side of the body and right cerebral hemisphere controls left side of the body. Brain affects learning greatly; it's the control center of the body. There are three types of learning styles: visual, auditory, and kinesthetic. Visual learners learn by seeing things, auditory learners learn by hearing things, and kinesthetic learners learn by doing things. These bring to the question: is there a correlation between brain dominations and learning styles? This research establishes an efficient, reliable passage to determine human's learning style and presents the correlation between the two factors, brain dominations and learning styles.

Index Terms—Auditory Learner, Brain Domination, Kinesthetic Learner, Learning Style, Visual Learner

1 Introduction

ABOUT 90% of the population is right-handed, and about 10% of the population is left-handed. The right side of the brain controls muscles on the left side of the body and the left side of the brain controls muscles on the right side of the body. Also, in general, sensory information from the left side of the body crosses over to the right side of the brain and information from the right side of the body crosses over to the left side of the brain. Therefore, damage to one side of the brain will affect the opposite side of the body. In general, most right-handers are left brain dominated and most left-handers are right-brain dominated. However, there are some right-handers that are right-brain dominated and some left-handers that are left-brain dominated. Also, there are very few people that are ambidextrous. Left-brain dominated people tend to be logical, sequential, rational, analytical, objective, and look at parts [31]. Right-brain dominated people tend to be random, intuitive, holistic, synthesizing, subjective, and they look at wholes [31].

There are three major types of learning styles: visual, auditory, and kinesthetic [14]. Visual learners are people who learn by seeing things [33]. These learners need to see the teacher's body language and facial expression to fully understand the content of a lesson and they are good with sign languages [11], [20]. Visual learners often make face expressions a lot. They tend to prefer sitting at the front of the classroom to avoid visual obstructions such as people's heads, people's body movements, etc [20]. Visual learners like to think in pictures and learn best from visual displays including: diagrams, illustrated text books, videos, charts, hand-outs, etc [14], [20]. They usually need quiet study times [11]. Visual learners are usually good at spelling [11]. Also, they are good at memorizing people's faces but not people's names [14]. Auditory learners are people who learn by hearing things [21]. Auditory learners learn best through verbal lectures, discussions, talking things through and listening to what others have to say [22]. Auditory learners aren't afraid to speak out in class and they can't keep quiet for long [1], [10]. Auditory learners often talk to themselves a lot [1], [10], [13]. They enjoy music and get distracted easily from music while doing homework [13]. These learners are good at remembering people's names but not faces [10], [11]. Kinesthetic learners are people who learn by doing and moving things [11]. They learn best through a hands-on approach, actively exploring the physical world around them [11], [20]. Usually, these learners can't sit still for long periods and may become distracted by their need for activity and exploration [11], [20]. Kinesthetic learners get fidgety easily during lectures and take breaks when studying [11]. They tend to study with loud music on [11]. Kinesthetic learners are usually good at sports and other physical activities [11], [18].

Numerous surveys can be found on different websites for determining our learning styles. However, the results highly depend on our own opinions of ourselves. Therefore, the surveys aren't very accurate. I designed my own series of tests and collected data from voluntary participants for this research. My hypothesis was that a correlation exists between brain dominations and learning styles. This paper will present a new approach to determine learning styles and the correlation that was found throughout this research.

2 Methods

2.1 Stage I-Preparing/Designing Tests

Based on all the background research work, numerous tests were designed to determine learning styles of participants. All tests were experimented with voluntary participants for improvement and adjustment during the designing stage. Data were not recorded at the time. After experimenting, ten tests were finalized for the actual research.

2.2 Stage II-Testing Session/Data Collecting

Voluntary participants were ages from ten to sixty. Right handed participants were assumed left brain dominated and left handed participants were assumed right brain dominated. Tests were given in order and test scores were recorded along each testing session. Throughout the testing session, if the participant made a great amount of face expressions, five points were added to the visual learner's category. If the participant talked audibly to himself/herself for a great amount, five points were added to auditory learner's category. if the participant made a great amount of ges-

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tures, five points were added to the kinesthetic learner's category.

2.2.1 Image Memory Test

1) A page with fifteen images was given to the participant to memorize in fifteen seconds.
2) After 7 seconds, two pages with thirty images including the previous fifteen images and another fifteen similar-looking images mixed together were given to the participant.
3) The participant had to find the fifteen images in the mixed version as much as possible.
4) The number of correct images that are found was recorded in the visual learner's category.

2.2.2 Faces and Names Memory Test (Two Tests in One)

1) Fifteen faces were shown to the participant while the researcher read their names at a constant rate twice.
2) Thirty faces with the previous fifteen faces and another fifteen similar-looking faces mixed together were shown to the participant.
3) The participant had to find the fifteen faces in the mixed version and name the faces as many as possible.
4) The number of correct faces was recorded in the visual learner's category.
5) The number of correct names was recorded in the auditory learner's category.

2.2.3 Story Listening Test

1) The participant was given a recording of a two-minute story to listen.
2) Fifteen questions about the story were given to the participant to answer.
3) The number of correct answers was recorded in the auditory learner's category.

2.2.4 Story Listening with Slap-Jack Test

1) The participant was given a recording of a two-minute story to listen while playing the card game, Slap-Jack, with the researcher.
2) Fifteen questions about the story were given to the participant to answer.
3) The number of correct answers was recorded in the kinesthetic learner's category.

2.2.5 Story Listening with War Test

1) The participant was given a recording of a two-minute story to listen while playing the card game, War, with the researcher.
2) Fifteen questions about the story were given to the participant to answer.
3) The number of correct answers was recorded in the kinesthetic learner's category.

2.2.6 Math Test

1) The math test consisted addition and subtraction problems between numbers one and one-hundred. A three-minute warm up was given to the participant.
2) The math test was given to the participant. The participant had to do as many problems as possible in one minute. This step was repeated three times.
3) The number of correct problems was recorded each time.
4) The average score of the three was recorded as a reference for later tests.

2.2.7 Math Test with Visual Distraction

1) The participant was given a new set of addition and subtraction problems between numbers one and one-hundred with a picture as the background of the page.
2) The participant was given one minute and had to do as many problems as possible within the time limit.
3) The number of correct problems was recorded. If the number was higher than the regular math test average score, no points were added in any category. If the number was lower than the average score, the number was then converted by calculating the percentage change between the regular math test average score and the math test with the background picture test score, followed by dividing the number by ten. The final number was recorded in the visual learner's category.

2.2.8 Math Test with Noise Distraction

1) The participant was given a new set of addition and subtraction problems between numbers one and one-hundred.
2) The participant was given one minute and had to do as many problems as possible within the time limit while listening to music.
3) The number of correct problems was recorded. If the number was higher than the regular math test average score, no points were added in any category. If the number was lower than the average score, the number was then converted by calculating the percentage change between the regular math test average score and the math test with the background picture test score, followed by dividing the number by ten. The final number was recorded in the auditory learner's category.

2.2.9 Math Test with the Activity Distraction

1) The participant was given a new set of addition and subtraction problems between numbers one and one-hundred.
2) The participant was given one minute and had to do as many problems as possible within the time limit while having the researcher jumping around the table.
3) The number of correct problems was recorded. If the number was higher than the regular math test average score, no points were added in any category. If the number was lower than the average score, the number was then converted by calculating the percentage change between the regular math test average score and the math test with the background picture test score, followed by dividing the number by ten. The final number was recorded in the kinesthetic learner's category.

2.3 Stage III-Post-Testing Session/Data Analyzation

After the testing session, scores of the three categories: visual, auditory, and kinesthetic, were totaled. The category with the highest score was determined as the participant's learning style. The participant may have

had multiple learning styles. If the categories' scores were three or less points within each other, the participant was determined for two or three learning styles. Data were then analyzed by using different software.

3 RESULTS

The results showed that 46.4% of left-brain dominated people are plain visual learners, 7.1% are plain auditory learners, 0.0% is plain kinesthetic learners, 35.7% are both visual and auditory learners, 7.1% are both auditory and kinesthetic learners, 0.0% is both visual and kinesthetic learners, and 3.6% are visual, auditory, and kinesthetic learners. 85.7% of left-brain dominated people are visual learners, 53.6% are auditory learners, and 10.7% are kinesthetic learners. 65.0% of right-brain dominated people are plain visual learners, 0.0% is plain auditory learners, 0.0% is plain kinesthetic learners, 25.0% are both visual and auditory learners, 0.0% is both auditory and kinesthetic learners, 5.0% are both visual and kinesthetic learners, and 5.0% are visual, auditory, and kinesthetic learners. 100.0% of right-brain dominated people are visual learners, 30.0% are auditory learners, and 10.0% are kinesthetic learners (Refer to Fig. 1, 2, 3, 4, 5, 6).

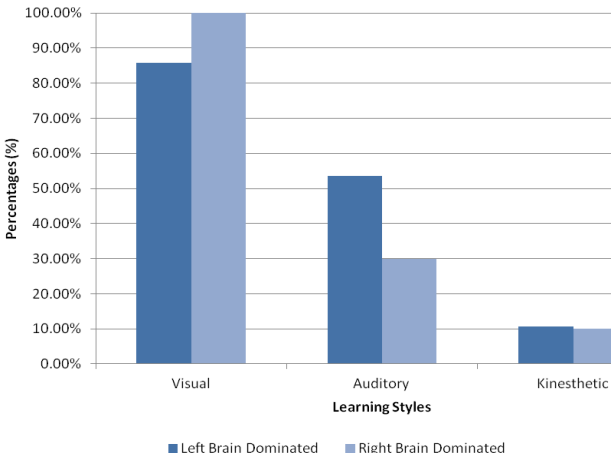

Fig. 3: Left and right brain dominated people's learning styles comparison (Analyzed by using single-learning styles).

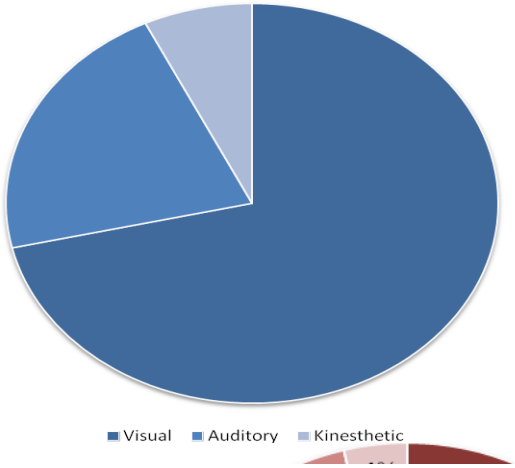

Fig. 1: Left brain dominated people's learning styles (Analyzed by using single-learning styles).

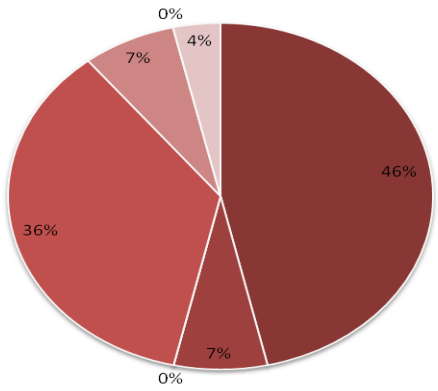

Fig. 4: Left brain dominated people's learning styles (Analyzed by using multiple-learning styles).

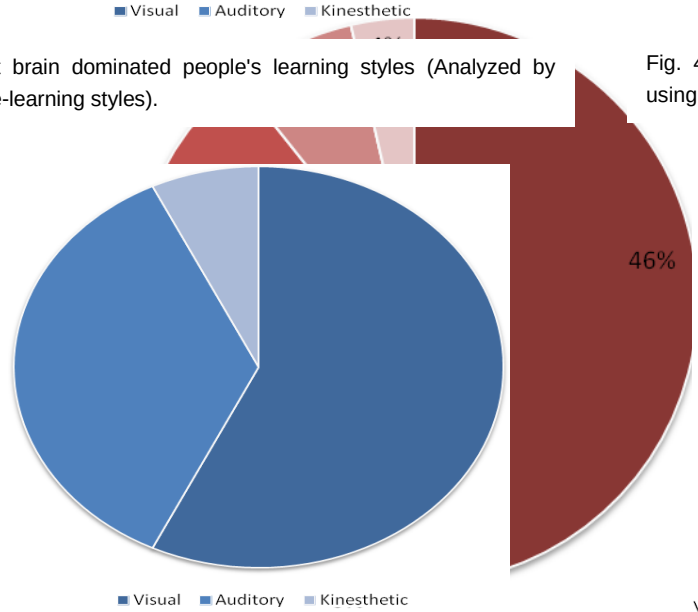

Fig. 2: Right brain dominated people's learning styles (Analyzed by using single-learning styles).

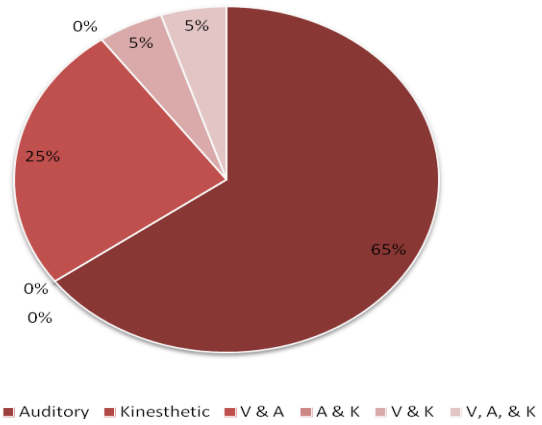

Fig. 5: Left brain dominated people's learning styles (Analyzed by using multiple-learning styles).

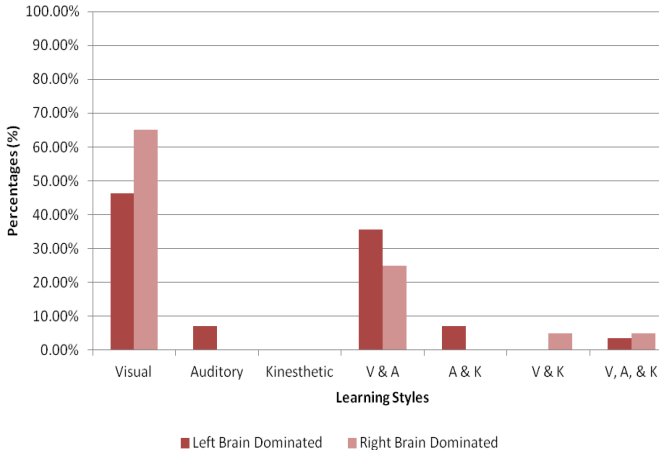

Fig. 6: Left and right brain dominated people's learning styles comparison (Analyzed by using multiple-learning styles).

The results showed that 60.7% of left-brain dominated people make many facial expressions, 53.6% talk to themselves audibly very often, and 53.6% make many gestures. 70.0% of right-brain dominated people make many facial expressions, 45.0% talk to themselves audibly very often, and 50.0% make many gestures (Refer to Fig. 7).

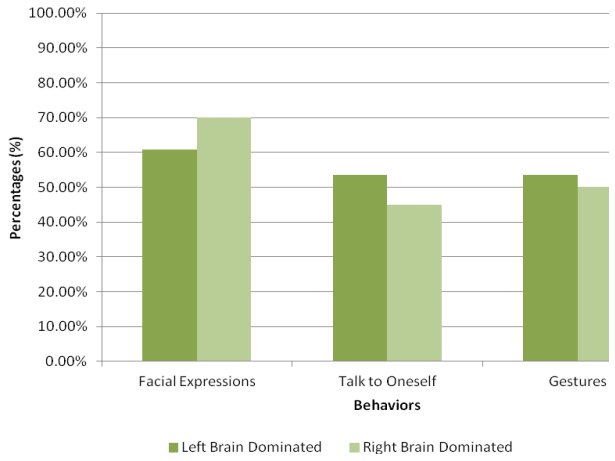

Fig. 7: Left and right brain dominated people's behaviors comparison.

The mean score for each test were calculated as well. For left-brain dominated people, the mean score is 10.4 out of 15 for the image memorization test, 7.3 out of 15 for the story listening test, 9.7 out of 15 for the face memorization test, 8.5 out of 15 for the name memorization test, 5.4 out of 15 for the slap-jack test, 5.8 out of 15 for the war test, 0.6 out of 10 for the picture distraction test, 0.4 out of 10 for the noise distraction test, and 0.3 out of 10 for the activity distraction test. For right-brain dominated people, the mean score is 9.4 out of 15 for the image memorization test, 5.9 out of 15 for the story listening test, 9.9 out of 15 for the face memorization test, 7.4 out of 15 for the name memorization test, 4.9 out of 15 for the slap-jack test, 4.8 out of 15 for the war test, 0.7 out of 10 for the picture distraction test, 0.4 out of 10 for the noise distraction test, and 0.7 out of 10 for the activity distraction test. 95% confidence intervals were calculated for each test and category scores (Refer to Fig. 8).

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Visual_Category_Total_Score** is **23.3571** plus or minus **1.92066**, ranging from **21.4365** to **25.2778**.
Right_Brain_Domination_Visual_Category_Total_Score is **23.45** plus or minus **2.10661**, ranging from **21.3434** to **25.5566**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Auditory_Category_Total_Score** is **19.0714** plus or minus **2.43687**, ranging from **16.6346** to **Right_Brain_Domination_Auditory_Category_Total_Score** is **15.4048** plus or minus **2.85598**, ranging from **12.5488** to **18.2607**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Kinesthetic_Category_Total_Score** is **14.1429** plus or minus **2.1896**, ranging from **11.9533** to **16.3325**.
Right_Brain_Domination_Kinesthetic_Category_Total_Score is **12.95** plus or minus **2.42463**, ranging from **10.5254** to **15.3746**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Image_Memorization_Test_Score** is **10.3571** plus or minus **0.962708**, ranging from **9.39443** to **11.3199**.
Right_Brain_Domination_Image_Memorization_Test_Score is **9.4** plus or minus **1.40322**, ranging from **7.99678** to **10.8032**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Face_Memorization_Test_Score** is **9.71429** plus or minus **0.937165**, ranging from **8.77712** to **10.6515**.
Right_Brain_Domination_Face_Memorization_Test_Score is **9.85** plus or minus **1.0873**, ranging from **8.7627** to **10.9373**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Picture_Distraction_Test_Score** is **0.571429** plus or minus **0.340807**, ranging from **0.230622** to **0.912235**.
Right_Brain_Domination_Picture_Distraction_Test_Score is **0.7** plus or minus **0.458056**, ranging from **0.241944** to **1.15806**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Story_Memorization_Score** is **7.25** plus or minus **1.24144**, ranging from **6.00856** to **8.49144**.
Right_Brain_Domination_Story_Memorization_Test_Score is **5.925** plus or minus **1.12936**, ranging from **4.79564** to **7.05436**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Name_Memorization_Test_Score** is **8.53571** plus or minus **1.09919**, ranging from **7.43652** to **9.63491**.
Right_Brain_Domination_Name_Memorization_Test_Score is **7.35** plus or minus **1.17887**, ranging from **6.17113** to **8.52887**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Noise_Distraction_Test_Score** is **0.428571** plus or minus **0.267579**, ranging from **0.160992** to **0.696151**.
Right_Brain_Dominatioin_Noise_Distraction_Test_Score is **0.35** plus or minus **0.436799**, ranging from **-0.0867988** to **0.786799**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Slap_Jack_Test_Score** is **5.375** plus or minus **1.19821**, ranging from **4.17679** to **6.57321**.
Right_Brain_Domination_Slap_Jack_Test_Score is **4.9** plus or minus **1.16287**, ranging from **3.73713** to **6.06287**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_War_Memorization_Test_Score** is **5.83929** plus or minus **1.21829**, ranging from **4.62099** to **7.05758**.
Right_Brain_Domination_War_Test_Score is **4.825** plus or minus **0.996503**, ranging from **3.8285** to **5.8215**.

Based on the sample, the **95.0** % confidence interval for the population mean of **Left_Brain_Domination_Activity_Distraction_Test_Score** is **0.25** plus or minus **0.271637**, ranging from **-0.0216368** to **0.521637**.
Right_Brain_Domination_Activity_Distraction_Test_Score is **0.7** plus or minus **1.0531**, ranging from **-0.353101** to **1.7531**.

Fig. 8: Confidence intervals.

Visual learners took the majorities for both brain dominations. However, auditory learners took a huge part in left-brain dominated people as well.

4 Conclusion

The results showed that 85.7% of left-brain dominated people are at least visual learners, 53.6% are at least auditory learners, and 10.7% are at least kinesthetic learners. 100% of right-brain dominated people are at least visual learners, 30% are at least auditory learners, and 10% are at least kinesthetic learners. 46.6% of left-brain dominated people are plain visual learners and 35.7% are both visual and auditory learners. 65.0% of right-brain dominated people are visual learners and only 25.0% are both visual and auditory learners. The hypothesis was supported by all results and conforms to brain and behavioral sciences; there is a correlation between brain dominations and learning styles. The correlation is that most left-brain dominated people learn better under visual learning or auditory learning or both. Most right-brain dominated people learn better under visual learning only.

5 Applications

This study can be applied in areas in brain and behavioral sciences. Possible applications are listed below:

1) Improve abilities of patients with damaged cerebral hemispheres. Damaged cerebral hemispheres usually come from strokes, car accidents, poisoning, etc. Variations of tests can be done and then be applied to these patients based on which part of their brain is damaged and help them to recover.
2) Improve abilities of mentally handicapped patients. Variations of tests can be done and then be applied to these patients to improve their daily life skills.
3) Prevent people from getting dementia or people with dementia from getting worse. Dementia is a loss of brain function that occurs with certain diseases. It affects memory, thinking, language, judgment, and behavior. Variations of tests can be done and then applied to these people to increase their abilities.
4) Improve teachers' teaching styles and help students to be more successful at school. Based on this study, a set of plans to improve teachers' teaching styles to fit all different kinds of learners learn well.
5) Develop young children's knowledge. Variations of tests can be done and then be applied to young children based on their brain domination. This will help to them to learn more by using their preferred learning styles.

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