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The Effect of the Hemispheres of the Brain and the Tone of Voice on Persuasion

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***Abstract*—**This study investigates whether participants experience different levels of persuasion depending on the hemisphere of the brain and the tone of voice. The experiment was performed on 96 volunteer undergraduate students taking an introductory course in psychology. The participants took part in a 2 x 3 (Hemisphere: left, right x Tone of Voice: positive, neutral, negative) Mixed Factorial Design to measure how much a person was persuaded. Results showed that the hemisphere of the brain and the tone of voice used did not significantly affect the results individually. Furthermore, there was no interaction effect. Therefore, the hemispheres of the brain and the tone of voice employed play insignificant roles in persuading a person.

***Keywords*—**Dichotic listening, brain hemisphere, tone of voice, persuasion.

I. Introduction

TO persuade is to convince someone or to make someone believe in the statement no matter the truth value. This of course, is the powerful function of persuasion because it essentially changes the belief of a person without necessarily using force. A study conducted by [1] on preschool children discovered that even young children can change the beliefs of their peers through the use of persuasion, without necessarily using force. The young children who participated were able to create meaningful arguments through their premature grasp of the other person's false beliefs and work their way around those conditions to convince others. Persuasion is then considered as one of the most important factors in daily life since it crosses many fields of life such as politics, advertising, and plain everyday communication. As mentioned by [2],

> *"It affects their [people's] sense of what is true or false, probable or improbable; their evaluations of people, events, ideas, or proposals; their private and public commitments to take this or that action; and perhaps even their basic values and ideologies."*

As such, persuasion is a key element in society today. There are different ways to make someone more persuasive to their listener. One method would be through the use of nonverbal cues. A person's beliefs can be altered based on the variation of different nonverbal cues [3]. An example of a nonverbal cue that can be used to persuade is the tone of voice.

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According to [4], tone is a quality in the voice that expresses the speaker's feelings or thoughts towards the person being spoken to. The tone of voice is then a way to express the intent of the persuader to the person being spoken to. According to [3], those who intend to persuade others would regulate the tone of their voice. This is through the use of a nonverbal type of manipulation. Since the tone of voice is a kind of nonverbal cue that persuaders use, this is a characteristic that they utilize in order to fulfill their intention. The tone of voice being used can then be detected and analyzed by those who are listening. The effect of tone is important enough that young children have the ability to detect and respond to these tones. As early as infancy, humans develop their social evaluation skills by using auditory information to assess the things that happen around them. The tone of voice is the infant's basis of social evaluation. In fact, [5] noted that infants prefer a puppet that spoke in a positive affect than a negative one. The tone is powerful enough that previous research claims that it is possible that the tone of voice is separate from the message being conveyed [6]. The results of [6] demonstrated that if the tone and the content contradicted each other, the tone overrode the power of the content of the statement, making the participants judge the positivity or negativity of the statement based on the tone. Following the study, [7] presented the 7% words- 35% tone- 55% body language rule in communication. However, the challenge for this rule is that the three components should support each other. A more powerful communication will be obtained if these three are of equal importance. Reference [8] argued that tone of voice tend to be contextual information in perception of the lexical meaning of words and this is also related to the idea that if the tone of voice goes with the lexical meaning of the content of the message, then the perception is faster, like how [9] discovered through blocking and mixing tones of voice that the emotional tone facilitated linguistic processing of linguistic content, further improving the recognition and naming of spoken words in an emotional scope.

Tone of voice also gets selective identification by each of the brain hemispheres. There is the right hemisphere and left hemisphere advantage for each kind emotion represented by the tone of voice. Aside from that, studies also found the relationship of hemispherical differences on the detection of emotion and speech-language processing. The right hemisphere was reported to be better in emotional information processing [10]. This also is somewhat connected to [11], wherein they discussed that the right hemisphere, through explanation of the left ear, is more on positive emotions and

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they got a result of no hemispherical preference for negative ones. This was supported by clinical data from studies that focused on people with brain injuries, which suggested that there was no detection of emotion with the people who had the damage on the left-hemisphere of the brain [12]. On the other hand, the left hemisphere is more connected to the comprehension of speech and language, which [13] explained by presenting that it is caused by the connection of the right ear in the language dominant left hemisphere. A right-ear-left-hemisphere relationship was also observed by [14]. Additionally, an experiment performed on split-brain individuals was able to physiologically prove that the left hemisphere is more active in processing speech. This lateralization is so apparent that the researchers who found that any related stimuli presented to the passive ear/hemisphere were transferred to the dominant hemisphere for information synthesis. With that, it is interesting to note how the structure and symmetry of the brain allows there to be two hemispheres with different functions. Since the 19th century, people have been studying to see whether or not one hemisphere is more superior to the other. With that, five models of hemispheric specialization were created in order to help explain the lateralization that many researchers had observed. The first one is unilateral specialization. In this model, the researcher is entertaining the idea that, although either hemisphere may have the capacity to perform a certain function, only one will [15]. For example, visuospatial and manipulo-spatial concerns are processed in one's right hemisphere while language, motor and executive functions are considered to be left hemisphere activities. The next model of hemispheric specialization is called bilateralization. In bilateralization, [15] states that both hemispheres are able to do any distinct task, albeit one hemisphere is possibly better than the other one. Contrary to what was mentioned earlier, [16] claims that language processing is actually a function of bilateralization. Her research suggests that the right hemisphere plays a vital role when it comes to understanding language and all of its intricacies, as proven by split brain patients [16]. Meanwhile, hemispheric dominance, the third model of specialization, states that the two hemispheres either collaborate with each other or hinder the other's ability to perform the required function [15]. The fourth specialization mechanism to be discussed is hemispheric parallelism. In this model, the two hemispheres work independently of and concurrently with each other. Finally, allocation is proposed to be the last model of specialization. This mechanism holds that, although both hemispheres are capable of performing a certain activity, only one will do so in normal conditions [15].

Among the five models of hemispheric specialization discussed, the most commonly used mechanism by theorists and scholars is unilateral specialization [15]. A study done by Reference [17] supports this lateralization type by claiming that the left hemisphere of the brain dominates language and auditory speech processing. Additionally, stroke patients who developed aphasia were studied, and it was found that the left hemisphere's activity level decreased. Ultimately, the aphasics whose left hemispheres fully healed were the ones who recovered the most from their condition [17].

Another noteworthy observation with regards to unilateral specialization is the right brain dominance in emotional processing. It was reported that stroke patients with major right hemisphere impairment showed a lesser capability to respond to prosodic emotional stimuli [18]. This may be due to the right hemisphere being more connected to the subcortical systems which process emotions, or to the emotional value present in the stimuli.

After reviewing 92 hemispheric lateralization through dichotic listening studies, [18] noted that the right hemisphere is invoked when processing negative emotions such as fear and sadness, while the left hemisphere is used when managing positive emotions like happiness and surprise. This observation is otherwise known as the valence hypotheses. It is regarded as an alternative to the older and more popular right hemisphere dominance hypothesis when trying to explain hemispheric lateralization and emotional comprehension. Reference [19] shows that the structures of the human amygdala and prefrontal cortex support the valence hypotheses. Reference [19] also discussed that patients who were diagnosed with major depression were found to have a smaller left amygdala, thus forcing their right amygdala to take charge of their emotions. Similarly, through the use of neuroimaging techniques, [20] were able to detect an increased activation in the prefrontal cortex' left hemisphere upon exposing participants to positive stimuli, while an increased activation in the prefrontal cortex' right hemisphere was observed upon exposing participants to negative stimuli. The left orbitofrontal portion of the brain was also noted to be more sensitive towards rewards, while the right orbitofrontal portion of the brain was more sensitive towards punishments [21].

One method that has been consistently used by researchers to test the hemispheres is the method of dichotic listening. Numerous studies have tested the different characteristics of the brain by using dichotic listening. Dichotic listening is listening to certain phrases, sounds, or words one ear at a time. This would force the participant to rely on only one ear, and therefore theoretically, on only one other hemisphere, to assess and interpret the stimuli. From the dysfunctional characteristics of the brain of an epileptic [22], to the differences between the functions of the brain between left-handed and right-handed people [10], dichotic listening has been a tried and tested method to observe the division of labor between the two hemispheres. This division allows researchers to pinpoint the strengths, as well as the weaknesses, of the two hemispheres and how one part compliments the other. These two hemispheres are connected by the Corpus Callosum which, surprisingly, does not have an overall significant effect on the distribution of certain tasks.

The Corpus Callosum is a major part of the brain that connects the cerebral cortices of both hemispheres. It plays a pivotal role in overall integration of both hemispheres in different activities [23]. However, this does not automatically

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imply that it will have a direct impact on the functions of the hemisphere of the brain and its asymmetry. Studies have shown that the Corpus Callosum's purpose in dichotic listening is to transfer left-ear input to the left hemisphere of the brain [23]. Generally, speech processing occurs in the left hemisphere [14], making the transfer of the left-ear input normal. As such, the Corpus Callosum does not affect the distribution of tasks for dichotic listening.

In order to observe the physical manifestation of hemispheric dominance, handedness provides a concrete medium to assess the differences of hemispheric dominance in other people. There are two general kinds of handedness. People are generally either right-handed or left-handed. Right-handed people are those whose dominant hand is their right while left-handed people are those whose dominant hand is their left hand. Previous research asserts that hemispheric dominance can be evaluated based on the dominant hand of the person. Through a dichotic listening task, participants in the study conducted in [24] exhibited that the Right-Ear Advantage (REA) is different between left-handed and right-handed people. Specifically, people whose dominant hand is their left hand have a lower REA than those whose dominant hand is their right. Ear advantage is important in the indication of hemispheric dominance. According to [34], the concept of ear advantage is intertwined with the notion that there is an overall preference in terms of processing stimuli. This is a good indicator of a person's hemispheric dominance, especially in the field of language. Having REA would mean that the left hemisphere has a better processing ability than the right hemisphere because the left is more dominant in that field. Since handedness is linked to varying REAs, handedness is therefore the outward indicator of hemispheric dominance.

Interestingly, the biological sex of a person has no significant effect on hemispheric dominance. Despite the differences between men and women biologically, this does not mean that in all cases, men and women behave differently. In fact, research asserts that gender has no bearing on hemispheric dominance. According to a study on left-ear advantage by [10], gender was found to have an insignificant interaction effect on ear preference. Ear preference was hypothesized by the study to be another indicator of hemispheric dominance. The study made use of dichotic listening to test the detection of emotional tones and apparently, despite stratifying the participants, gender did not affect the results significantly.

In conducting this experiment, statements will be used to project the tone of voice. This study uses neutral statements which are defined to be statements without adjectives and the subject should be unfamiliar to the participants. No studies have yet focused on neutral statements however, generic statements were defined. These generic ones are statements that express generalizations. The subject being used is familiar but it is stated in a generalized manner.

With the guidance of previous research, the current study hypothesizes that the hemisphere of the brain will have a significant main effect on persuasion (Hypothesis 1) and the tone of voice used will have a significant main effect on persuasion as well (Hypothesis 2). The researchers of the study are also expecting there to be an interaction effect between the hemisphere of a person and the tone of voice used (Hypothesis 3).

II. Method

A. Participants

After running computations through G*Power version 3, and studying the different sample sizes in previous related studies, it was decided to recruit 84 undergraduate students enrolled in Psych 101 in the University of the Philippines, Diliman to participate in this experiment in order to maximize the power of the results. A sign-up sheet was posted on the third floor Lagmay Hall bulletin board on April 13, 2016 so that interested students could express their intention to join the experiment. Convenience sampling was used to gather participants. One 30 minute class credit sticker was given to each participant for their contribution to the study.

At the end of the study, a total of 96 participants volunteered to participate in the experiment. However, of the 96 responses collected, 11 were scrapped because the participant was left handed, while another one was scrapped because of the participant's failure to properly complete the scoring sheets. In sum, 12 participants were scrapped, with the initial desired number of 84 right-handed participants.

B. Materials

Headphones were used to administer the treatment conditions for the experiment. To make the execution of the experiment efficient, two headphones were available during that time. One set of headphones was white, Sony brand headphones, while the other were red and black unbranded headphones. Two 13" MacBook Air laptops were also used. These laptops served as the medium where the audio and the videos were played. The participants were asked to wear a sleeping mask prior to the experiment proper. There were two sleeping masks provided, one per setup. This was to ensure that the experiment was a purely listening experience. Twenty-four sheets of one-fourth short bond paper and a black ballpoint pen were also provided per participant. This was where they wrote their ratings of the statements that they listened to.

C. Neutral Statements

All statements used in the experiment, including those in the trial rounds, went through a pilot test in order to test their neutrality. There were two pilot tests conducted specifically for the nature of the statements to be used in the experiment. The first pilot test was concerned with the perception of what a positive, negative or neutral statement would be. The statement that rated the most positive, the most negative and the most neutral were used in the actual experiment for the trial round. The second pilot test was to test if the 20 statements created from the knowledge brought by the first pilot test were indeed neutral. Both pilot tests were answered

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solely by *Experimental Psychology* students of the same class in the University of the Philippines Diliman. They were asked to rate the statement using a scale of 1 to 5, with 1 being the least positive and 5 being the most positive. The scores of each statement was compiled and averaged after a sufficient number of respondents completed the form. The closer the statement is to an average of 3, the more neutral the statement was for the respondents. The number of syllables per statements was controlled in accordance to research from previous studies [10], [25], to ensure that the length of the statements did not have a significant effect on the level of processing that a participant in the study would make. All statements used in the experiment had a syllable count between seven and nine syllables.

After conducting pilot tests for the neutrality of each statement, we conducted another, separate pilot test for the perceived vocal tone. All 20 statements were recorded using *Audacity* in three different tones: Positive, Neutral, and Negative. The more specific tone used for the Positive tone of voice was Happy while for the Negative tone of voice, the researchers used Sad. There were 60 different recordings for the statements in the experimental procedure alone. The experiment used a total of 63 recordings, with three of those being the informed consent audio, the instructions audio and the trial round audio. All recordings were made using the voice of only one student who is a sophomore student from the College of Mass Communication who also worked part time as a DJ. The recruited speaker was asked to modulate her voice in order to control the loudness and the speed to make these factors consistent in all the statements. The statements were then presented to the whole class for evaluation. After making necessary adjustments according to the class's recommendations, the subsequent statements were then pilot tested in the final pilot test.

Lastly, a pilot test on the entire experimental procedure was conducted before the actual experimentation period. Undergraduate psychology students taking *Experimental Psychology*, as well as other students who have previously taken Psychology 101 in a previous semester, were asked to participate. The pilot test was conducted in the same manner as the procedure of the actual experiment. The researchers were able to recruit seven students to participate.

D. Procedure

For this experiment, a 2 x 3 (Hemisphere: left, right x Tone of Voice: positive, neutral, negative) Mixed Factorial Design was used. The Hemisphere conditions utilized a Within-Subjects Factorial Design while the Tone of Voice conditions made use of a Between-Subject Factorial Design. Due to counterbalancing, the number of conditions rose to 12. Additionally, the sequence of the statements used was counterbalanced; ergo, the experiment consisted of two different sequences of the same set of statements. The ear in which the statements were presented to, however, only followed one order for both statement sequences. Ultimately, the experiment had 12 conditions, considering all the independent variables and counterbalancing efforts.

Before the start of the experiment proper, the participants were randomly assigned to two of the 12 possible conditions. The sequence of the statements used was counterbalanced in order to eliminate any confounding variables brought about by statement placement. They were equally distributed between the different conditions of the experiment. During the actual experimentation period, we were able to accommodate two participants at the same time. These two participants were exposed to two different experiment setups and therefore, two different conditions. The experiment lasted for less than 10 minutes per participant.

Participants were led to one of two similar experimental setups. The participants were seated and given the informed consent forms while an audio track of the informed consent played. Upon signing the form, they were handed a blindfold to wear. The researchers assisted them in putting on the blindfolds as well as the headphones provided. The orientation of the headphones was counterbalanced in order to avoid physical instrumentation errors. The researchers gave the participant a pen, and positioned the sheets and the hand of the participant in such a way that they would be able to write despite being blindfolded. Once the participant was ready, the audio for instructions was played. All recordings used were attached to a video that displayed text of what the participant was hearing on the laptop. The laptop faced the researcher to ensure that there would be no confusion as to where the participant was in the experiment.

The participants were deceived into thinking that the experiment was about their hearing ability and understanding of the statement by being informed that they were participating in that kind of experiment. Participants were then asked to evaluate the truthfulness of a statement from a scale of 1 to 6, with 1 being the least truthful and 6 being the most truthful. This was the measure of how persuasive the statement was. The more truthful the participant thought the statement was, the more persuasive the statement. From the total of 24 statements, four of the statements were used for the trial round prior to the experiment proper. Participants were informed that all statements were independent of each other in the instructions. Since the participants were blindfolded, a set of 24 sheets of paper and a black ballpoint pen were placed in front of the participant so that they could write down their answers. These sheets of paper were stapled and every sheet corresponded to a rating for one statement. Participants were given one trial round before the start of the actual experiment; the trial round contained four statements that they would have to rate using the aforementioned scale. After the trial round, the participants were asked to give a thumbs up sign if they understood the instructions. If they had any further questions, they were given the opportunity to ask them before the actual experiment began. In the actual experiment, 20 consecutive statements were played and each participant rated the truthfulness of the statement on the paper in three seconds. This time interval was characterized by a beep sound per second that passed. After three seconds, the researcher present

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would turn the page for the participant, and the next statement would play. This was done to eliminate the need to remove the blindfold. This sequence proceeded until all statements were exhausted. Afterwards, participants were asked to remove the blindfold and were led outside to be debriefed. Researchers gave them their credit sticker, which served as their credit for participating in the experiment. Data were recorded and analyzed using SPSS 22.0.

III. Results

A. Manipulation Check

It was noted that the manipulation was not effective since a number of the participants were unable to differentiate the negative and neutral tones ($N_{TotalNeutral}$ = 28, $N_{CorrectNeutral}$ = 14, $N_{TotalNegative}$= 28, $N_{CorrectNegative}$ = 1). Furthermore, only a considerable number of participants were able to identify the tone used ($N_{Correct}$ = 53). Among these, a few also identified two tones that contradicted each other ($N_{Contradictory}$ = 13).

B. Descriptives

The data were analyzed using a 0.05 level of significance for every statistical test =0.05. An analysis of the descriptive statistics showed that people are mostly persuaded by a positive tone of voice (M = 3.354, SD = 0.173). The negative tone of voice was the second most persuasive tone (M = 3.346, SD = 0.173) and the neutral tone of voice was the least persuasive (M = 3.278, SD = 0.173). The descriptive statistical analysis also stated that the participants were more persuaded by the statements presented to their left hemisphere (M = 3.39, SD = 1.00) than by statements that were administered to their right hemispheres (M = 3.26, SD = 0.94). The results also displayed that participants were most persuaded by statements expressed in a positive tone to their left hemispheres (M = 3.51, SD = 1.06). The second most persuasive combination according to the analysis were statements that were spoken in a negative tone to the right hemisphere (M = 3.35, SD = 0.90), closely followed by statements vocalized in a negative tone but to the left hemisphere (M = 3.34, SD = 1.04). Statements articulated using the neutral tone of voice to the left hemisphere (M = 3.32, SD = 0.92) were less persuasive than the same statements said in a negative tone to the same hemisphere but more persuasive than statements administered to the right hemisphere of the same tone (M = 3.23, SD = 0.98). The least persuasive combination, according to the statistical analysis, were statements administered to the right hemisphere using a positive tone (M = 3.19, SD = 0.96).

C. Main Effects

The main effects of the experiment were examined using the Mixed Analysis of Variance. According to the results, the main effect for the tone of voice was not significant, $F(2, 81) = 0.058$, $p > 0.05$, Partial 2= 0.001. The results also stated that the main effect for the hemispheres was marginally significant, $F(1, 81) = 3.081$, $p > 0.05$, Partial 2= 0.37. The interaction effect was also not significant $F(1, 81) = 1.609$, $p > 0.05$, Partial 2= 0.38.

IV. Discussion

The results revealed that both the main effects for the tone of voice and brain hemisphere yielded no significant result. The same is true with the interaction of the two variables which also failed to show any statistical significance. Thus, no previously stated hypothesis was accepted for this study.

A. Brain Hemisphere

Contrary to Hypothesis 1 which claims that brain hemisphere would have a significant main effect on persuasion, the results of the current experiment show that the persuasion means of those who processed statements through their left hemispheres are statistically the same as the persuasion means of those who processed statements through their right hemispheres. These results were most likely obtained due to the fact that the predicted model of hemispheric specialization was not observed. Reference [15] stated that unilateral specialization was the most commonly utilized model in the academe. However, this experiment shows that bilateralization, one of the four other models of hemispheric specialization proposed by [15], was more apparent among the participants. The results of the experiment support this model as both hemispheres were capable of processing data, although, technically, the statements processed by the left hemisphere were perceived as more persuasive than those processed by the right hemisphere.

Additionally, the results obtained during the experiment very much agree with [16] stand on language processing and bilateralization. It was evident in the researchers' findings that the right hemisphere displayed the ability to process the prosodic and non-lexical aspects of spoken speech. Moreover, the results of this study are supported by [26] who claim that a bilateralization will emerge if the emotion depicted in the stimulus is not conspicuous. This is because neither the left nor right hemisphere is superior to the other when it comes to subliminal prosodic processing. In particular, the right hemisphere dominance hypothesis may only be seen when participants are asked to perform an explicit prosody identification task [27]. Thus, it is more likely for the right brain to dominate the participants' emotional prosody processing when they are instructed to determine which of a certain set of words was said in a specific emotional tone. On the other hand, studies show that when a participant is tasked to identify a separate variable which is said in different tones, the dominance of the right hemisphere in terms of emotional processing disappears [27].

The findings of [26], [27] may be seen in the experiment's results as statements presented to the left hemisphere technically appeared more persuasive than statements presented to the right hemisphere. Truly, no right hemisphere dominance was noted with relation to prosodic processing with regards to this experiment. This bilateralization was most likely caused by our instructions to the participants to rate the statements based on their truth values, or persuasiveness, and not to identify the emotional tone of voice that they would hear. As explained earlier, the lack of instructions to explicitly

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ascertain what tone they were hearing may have caused the right hemisphere to lose its emotional processing advantage over the left hemisphere. As a result, the left hemisphere played a bigger role in the processing of the statements and their persuasiveness, thereby showing no statistical difference between the persuasive means of the statements presented to the left and right hemispheres.

Ultimately, the experiment showed that both left and right hemispheres are in use during language comprehension. This is a noteworthy discovery as it strengthens all claims that challenge the traditional notion of left hemisphere lateralization for language. With more study, it is possible that a significant result can be found, and a revolutionary conclusion be made, changing popular notions regarding language and lateralization.

B. Tone of Voice

In particular, the tone of voice yielded insignificant results and our hypothesis was not supported. However, the three tones of voice used in the experiment yielded differences with each other. The positive tone of voice got the highest score on persuasion, followed by the negative tone and least is neutral tone. It is also important to note that both positive tone and negative tone seemingly differ with neutral tone. With regard to the ineffective tone of voice in general, we discovered that although the statements were neutral, it is possible that they were distinguished separately with the tone of voice that was being used. Rodd and colleagues argued in their studies that whenever our brain listens to words, those words were distinguished in the left temporal lobe for processing and the tone of voice was analyzed in the right side of the brain, which is more inclined in music or melody recognition. With this, we can deduce that two areas in the brain are being used when recognizing and hearing words being communicated to us. They further explained when they measured the brain activity while listening to dialogues that the brain can solely separate the language itself from any other sound. The speech was singled out for special treatment near the primary auditory cortex [28]. We could then consider that meanings were still processed for the statements that we used and the tone of voice was obscured because of this, giving this little to no effect at all.

The pattern of the result for this variable exhibited the positive tone getting the highest score, followed by the negative tone. The least of them was the neutral tone of voice. Emotions as presented by the tone of voice will affect persuasion compared to having no emotion, which is similar to talking in a neutral tone. This can be supported by the study of [29] that explains how emotion takes action when comprehension is constrained. Thus, emotions were actually instigated to have an effect on persuasion. This is also related to the idea that emotions alter persuasive impact and that persuasion would be more successful when framed with emotional overtones [30].

Even if the variable's effect is insignificant, we cannot deny that certain tones of voice are widely used and encouraged to use for persuasive communication. Examples of these are found in the communication skills-related books of [31], [32]. Although it is not specifically supported by studies about tone differences, the studies on the effects of emotions on persuasion connected these ideas. Since this study contradicted the norm, it is advisable to take a critical view at its importance because it is now probable that emotions represented by tone of voice are not actually that effective in the art of persuading.

C. Interaction Effect

As mentioned earlier, the interaction effect between brain hemispheres and tone of voice proved to be insignificant. This insignificance could have been influenced by the number of participants not being able to distinguish between the specific tone used for their set of statements. The hemispheres are partly responsible for tone recognition. Reference [24] used a similar methodology and obtained the same results. Sentences that were listened to using the left ear had significant superiority in accurate judgment of tones. This is because the right hemisphere, which is the region of the brain directly connected to the left ear, is more adept at distinguishing emotions than its left counterpart [24]. However, the methodology of the experiment made use of both hemispheres and participants were asked to elucidate the specific tone used for all the statements that both ears had a chance to listen to in equal parts. This would then influence the prefrontal cortex, the section of the frontal lobe responsible for decision-making [19]. Since the left hemisphere is less accurate in judging tones than the right hemisphere, the entire cortex of the brain would take into account information coming in from both the left and the right to arrive at a decision of the tone the participants heard. Despite accuracy in the right hemisphere, if the left hemisphere was not able to arrive at the same tone perception, a disjunction would take place and would lead to an inaccurate decision of tone. This would also provide another explanation as to why despite only having one tone used in the experiment per condition, participants would state that there were two tones, giving an interpretation that is only half right. This is concrete evidence of the two different hemispheres having two different perceptions of tone. It is also a hemisphere-related explanation on the study that negative tones can be perceived positively [33]. Despite the tones being negative, there was inclination to believing their positivity. This occurrence was also observed in the study. In addition, the valence hypotheses, which states that the right hemisphere is more inclined to process negative emotions, while the left hemisphere is more adept to processing positive and neutral emotions, agree with the results in concluding that there was no hemispheric dominance with regards to the tones of voice used in the statements [18]. This is due to the fact that both hemispheres were utilized in the processing of the different emotional tones [19]. Furthermore, the trend of which hemisphere and tone of voice combination was perceived to be the most persuasive follows the valence hypotheses with the left hemisphere deeming statements more

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persuasive when said in a positive or neutral tone, and the right hemisphere judging them to be more persuasive when said in a negative tone.

The aforementioned trend shows that statements said in a positive tone of voice that were processed by the left hemisphere were identified as the most persuasive statements, while those said in a negative tone of voice, and were processed by the right hemisphere were interpreted as the second most persuasive. This can be explained by looking at one of the major decision making regions of the brain: the prefrontal cortex. The prefrontal cortex is a highly asymmetrical part of the frontal lobe, when it comes to affect processing. Positive affect and approach behaviors are heavily linked to the anterior left hemisphere while a sense of reward is associated with the left orbitofrontal region. Concurrently, the right anterior portion of the prefrontal cortex is connected to negative affect and withdrawal behaviors while the right orbitofrontal region is linked to punishment [19]. As a result, the participants were more persuaded by the positive statements they heard from their right ears (left hemispheres) as these induced a sense of reward upon deciding to agree with the introduced stimulus. The negative tones presented to the right hemisphere also proved to be relatively persuasive because the negative emotion to which the right hemisphere is associated with is in line with the sense of punishment the right prefrontal cortex elicits. This congruence is regarded by the cortex as logical, thus making the negative statements that are processed by the right hemisphere look persuasive to the participants. The explanation provided by the prefrontal cortex may also be used to justify the experiment's least persuasive tone of voice and hemisphere combination: positive tones processed by the right hemisphere. This combination is contradictory; with the positive tones evoking a positive affect which the right hemisphere is forced to attend to. The mismatched pair signals to the participant that their reasoning is invalid, therefore making the statement appear untrue and unpersuasive.

Despite the statistical insignificance, the results of this experiment may potentially affect the way people view emotional processing, and its relationship with hemispheric dominance and data comprehension. It brings to light specific situations wherein the more popular right hemisphere dominance hypothesis is inapplicable, and the valence hypotheses should be considered. This, in turn, may shift society's viewpoint regarding the matter, and may change the way people approach issues on emotional understanding.

D. Limitations and Recommendations

The study is limited methodologically, mainly because a number of the participants were not able to answer the manipulation check accurately. This means that the manipulation of the tones of the voice used was not so clear to the subjects. To some extent, it could represent an ineffective manipulation for the tones of the voice used. This could explain why the negative and neutral tones did not have much of a difference in means achieved. Furthermore, the test only used three specific tones: happy, neutral, and sad. This limits the study since it is unclear if the persuasion of the subjects would vary with other tones despite testing for a generally positive, neutral, and negative tone. The study also only focused on right-handed people. While the test favored right-handed people due to natural asymmetry in the brain hemispheres, it is also important to know how left-handed people would fare in the study since the hemispheres located in the brains of left-handed people are more symmetrical. Finally, the study only applies to a specific age group. It could also be possible that the hemispherical processing in different age groups can act differently compared to the specific age group used in the study.

The tone of the voice main effect might also be limited by two possible reasons. One of these is the idea that the manipulation check for the tone of voice was not effective. The participants tended to misinterpret the tone of voice that they have been hearing in the experiment; although, it may also be possible that the participants are only playing safe in their answers in the manipulation check. Since neutral tone was the answer of most participants, the authors of the study assume that this maybe because the participants were playing safe in their answers. They might have considered neutral as the safest answer compared to answering positive or negative. The second possible reason is that the prolonged administration of the tone of voice affected their perception of the tone that they have been hearing. Twenty statements were presented along with the tone and the participants maybe got used to the tone that they heard in the experiment. The longer the statements are heard with a consistent tone of voice, the more that the perception of the tones would equalize with each other.

We advise that future experimenters take into account a number of suggestions. First, it is apparent that the study only exposed the participants to three very specific tones: happy, neutral and sad, which made up the three tone conditions: positive, neutral and negative. The researchers are aware that a variety of other tones can be categorized into positive, neutral or negative, but these three were chosen because of their familiarity. Future research on other tones and their effect on persuasion are recommended. Second, future researchers who plan to use the same methodology are advised to use, at most, 12 statements only. It is possible that too much exposure to a certain tone could have potentially led to the participants thinking that other tones were also neutral in tone. Previous studies on dichotic listening only made use of five to 12 statements [10], [25]. Keeping within that range is recommended. We also propose that the statements be administered to both ears before moving on to the next statement. The current study's procedure only made the participant listen to the statement once, in only one ear. In order to balance this, other participants would listen to the same statement in the same tone, but in a different ear. For parsimony reasons, it is recommended that the statement be administered to both ears before moving on to the next. Since the study was only limited to right handed participants, a study

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conducted on left handed participants would also be beneficial to the addition of knowledge on this area. Lastly, it is recommended that one uses a greater sample size when replicating the experiment. This may increase the significance of the variables used, especially the brain hemispheres.

V. Conclusion

Despite the nonsignificance of all the factors in the study, the findings of the experiment have revolutionary implications. First, language comprehension has proven to be a bilateralization task, instead of a unilateral specialization task, as previously believed. This finding may have a truly significant impact, especially in the lives of those with speech or language disorders. By utilizing both, instead of only one hemisphere when providing rehabilitation exercises to these patients, therapists can ensure a greater success rate; thus, enhancing the quality of life experienced by those suffering from these kinds of disorders. Additionally, even people without any kind of disorder can benefit from this outcome by realizing that it does not matter which hemisphere per se they are speaking to when they are trying to be persuasive. Ergo, everyone from marketers to potential suitors may deliver their messages without having to worry that they are at a disadvantage because of their location relative to their target audience.

Although the overall result for tone of voice is insignificant, it can still be deduced that the emotions represented by one's tone of voice take part on persuasion communication, especially when comprehension is restricted. This can be seen in the trend that resulted in positive tone as the most persuasive followed by negative, and the least being the neutral tone. In connection to that, emotions should also be explicitly presented for there to be a right hemisphere advantage, otherwise both hemispheres would just do the processing of information. Knowing these ideas would help in everyday living especially since the core of relationships with other people is the communication enjoyed between them.

It was noted that despite there being a trend, at least for the tones of happy, sad, and neutral, tone of voice does not have a significant persuasive power. Meaning, only adopting a specific tone of voice would not be able to guarantee becoming more persuasive to others. It is therefore disproven that only a specific tone of voice would be the key to being a persuasive person. Other methods must be utilized in order to increase the persuasive power of a person because tone of voice alone lacks the ability. This finding is again beneficial to groups relying on marketing. Specifically, it is not enough that the product must be presented with a speaker introducing it in a specific tone of voice because it has been proven that the tone of voice will not increase the other person's perception of it being believable. People use both their audio and visual faculties in order to judge emotional content and it would be more beneficial if commercials in general would be seen and heard, rather than just heard. In connection to that, people are likely to judge tones incorrectly. These findings can also be applied to everyday digital communication. In the digital age where it is possible to speak with someone via a telephone without the visual, hearing the tone of voice alone could lead to misunderstanding in the emotional content that the person speaking is trying to deliver. Miscommunication is then rampant in this medium alone. Therefore, this is a good justification to use digital communicative measures that have both audio and visual features, boosting understanding in the emotional content of the message between both users, which in turn minimizes possible causes of misunderstanding.

Ultimately, the key to being persuasive relies on another dimension, or at least an interaction of other variables, rather than just tone of voice and hemispheres alone.

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