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Fluency in Discourse for Female RHD Participants

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Abstract

This paper conducts a cross sectional study on 4 Bangla speaking RHD (right hemisphere of the brain damaged) participants at the level of discourse, along with 4 age and gender matched controls. We are looking at the fluency in discourse, for these participants. Fluency or words spoken per minute is the number of words spoken in a minute. While making a discourse, every person has an average rate at which they speak and this is fluency in discourse. The average rate at which a person speaks in a discourse has been manually calculated from the mentioned 4 RHD and 4 control participants and then tabulated and compared. Participants with damage to the right hemisphere of the brain have been seen to have stammering speech and a slower rate of fluency in comparison with normal people. This paper puts that hypothesis to the test and compares 4 RHD participants with 4 age- and gender-matched normal controls.

The study procedure consisted of narrating two short stories to the participants and then requesting them to narrate back the story, which was recorded by the researcher. The recordings were analyzed in Praat, where the number of words spoken in a minute or fluency in discourse was calculated. Fluency was tabulated using Ms. Excel. The 4 participants have been compared to single controls and to the mean of the whole group.

This paper has found out that there is a marked difference between the fluency ranges of the RHD participants at 123 words per minute in comparison with the controls at 132 words per minute, proving that RHD participants have a lesser rate of words per minute spoken in discourse.

1. Introduction

The right hemisphere of the brain primarily controls the voluntary activities in the left side of the body. Apart from that it imparts personalities to human beings, making us unique and novel and different from each other. The right hemisphere of the brain is also responsible for helping us comprehend the theme of situations, in particular, of discourses. It helps in understanding what is being spoken about, so that we can speak relevant things. The right hemisphere further helps with understanding metaphors and imageries. The right hemisphere is responsible for giving us the sense of perception and when it is damaged the subjects affected can lose the sense of perception. Left side of the body neglect is very common among subjects with right hemisphere damage. The right hemisphere helps recognise tones in voices as well as other para-linguistic cues in voice which help us understand conversations better. The right hemisphere also gives us the ability to use the frequency modulations, we do, in normal conversations to express various para-linguistic messages along with normal speech (Springer, Deutsch, 1993, Weisenberg, 1935, Rachel and Crow, 2005, Metcalfe, Funnell and Gazzaniga, 1995, Moor, 1982, Robinson, Kubos, Starr, Rao, Price, 1984, Vallar, Perani, 1986, Bihrlea, Brownell, Powelsona and Gardnerc, 1986, Ozonoff, Miller, 1996, Gordon, Hewer, Wade, 1987, Narang, 2009).

However, in this research paper, we shall take a look at the fluency rate in discourse. We shall compare four right hemisphere damaged female participants (to be henceforth referred to as RHD participants) in comparison with age and gender matched controls. We shall also compare them to the mean of the whole RHD group (mean of all the RHD participants) and the mean of the whole control group.

1.1. The Present Study

The present study falls under the broad area of neurolinguistics. It is an empirical study which involves the collection of primary data RHD participants along with age and gender matched normal controls preferably from the same family as the RHD subjects. It is not a longitudinal study. It is a cross sectional study. The present study would look into the fluency rates of words spoken per minute by RHD participants in comparison with age and gender matched normal controls, at the level of discourse.

In the next section we shall do a short literature review of relevant literature to understand the nature and intensity of damage. Throughout my field study, I have come across various RHD participants and it was a clear fact that the fluency at which we can speak differs in every individual but RHD participants generally have a much lower fluency rate in comparison with normal people. This also makes it difficult for the listener to understand speech. The literature review shall discuss similar issues, faced by researchers before. We shall discuss the research methodology in the section following literature review and it would elaborate the various steps taken throughout the field study, for studying the participants, as well as controls from the same family or similar socio-economic backgrounds. This would be followed by a section called case study, which would discuss the background of the RHD participants included in this study. The final section would house the discussions and analysis found from the data presented in the subsequent sections.

2. Literature Review

A paper by Ropper A.H., *Severe dysarthria with right hemisphere stroke*, mentions that stroke to the right hemisphere can cause highly slurred speech. It is also accompanied by variable degrees of hemiparesis depending on the degree of brain damage. The author has done a test involving dysarthric participants and has come to the conclusion that dysarthria can be caused due to a lesion in the right brain. Participants with dysarthria have difficulties in articulating vowels. They have a problem in using the active articulators of speech. Depending on the degree of damage of an individual and the right brain, the level of control in RHD participants depends and varies. The acoustic vowel space for such individuals also vary depending on the amount of brain damage caused. (Ropper, 1987, 1061-63)

The article Dysphagia In Acute Stroke (Caroline Gordon, 1987) studied the incidence, duration and reason for dysphagia in stroke patients. Dysphagia is referred to a clinical condition in which a subject in unable to swallow food due loss of motor control from the parts concerned. A total of 91 subjects were tested on as random selections. 41 subjects were admitted with dysphagia and 37 subjects out of the 41 subjects had a lesion in any one of the hemispheres. Seven subjects had lesions in bothe the brain hemispheres. Nineteen of these subjects regained

back the ability to swallow in fourteen days from the date of their strokes. The authors conclude by stating that stroke in any one hemisphere of the brain can cause more incidences of dysphagia then unilateral stroke to both the hemispheres. In unilateral stroke cases, as the author states and hypothises , due to cerebral oedema to the brain stem, one can lose control of the motor activities inside the mouth; but this does not explain all cases. The central cerebral artery is responsible for the supply of blood to many regions which are responsible for swallowing. Infarctions at such regions and ischemic strokes, can cause swallowing problems. There is also another scenario in which it has been noted that many apraxic subjects have displayed dysphagia. Regarding this, it has been hypothesized that brain regions responsible for swallowing might be near to the regions which cause apraxia in the brain. There is no hard and fast factor which can be pointed out for dysphagia in subjects. (Caroline Gordon, Richard Langton Hewer, Derick T. Wade, 1987)

Ropper mentions that damage to the right hemisphere of the brain also causes slurred speech, in the paper Severe dysarthria with right hemisphere stroke (Ropper, 1987, pp 1061-63). The more the area damaged, the more the level of slurring. Subjects with damage to the right hemisphere of the brain have problems in articulating vowels, as a result. They also have a very limited frequency range in their speech, according to Behrens, in the paper Characterizing sentence intonation in a right hemisphere-damaged population (Behrens, 1989). They have much lesser range between their maximum and minimum pitch. It has also been noticed that they have a much lesser f0 or fundamental frequency level. Subjects with damage to the right hemisphere display problems in modulating their fundamental frequency. It has also been noticed in the paper The Role of the right hemisphere in emotional communication (Blonder, Bowers, Heilman, 1990, pp 1115-27) that damage to the right hemisphere can cause the inability to understand facial expressions, tones, metaphors, imageries and the comprehension of gestures, emotions without spoken communication and so on. Such subjects suffer major disruptions in nonverbal communication.

According to the book, Left Brain Right Brain by Springer and Deutsch, damage to the posterior left temporal cortex or Wernicke's area causes problems in speech comprehension. Participants with such an aphasia have problems in understanding what is being told to them. They have major problems in understanding communication, yet they have no problems in

speaking correct sentences, no matter how absurd they sound. Their sentences are grammatically correct. Anomic aphasia refers to a condition of an individual who has problems in recalling words. Any person who is affected by anomic aphasia has extreme problems in remembering names and coming up with words for a sentence they are speaking. Primary Progressive aphasia refers to a condition where an individual gradually loses the ability to read, write, and speak or to comprehend. While the wide horizon of communication windows slowly lessens down for such participants they develop new ways to communicate with other human beings like gestural communication. Deaf people use sign language to speak. Sign language is a fully developed way of speaking for deaf signers. It has been noted that deaf people with aphasia have similar problems as normal participants with aphasia. Global aphasia refers to a condition when a person has a widespread brain damage and two or more symptoms and kinds of aphasias take place at once. Participants with global aphasia can have symptoms of both Broca's aphasia and Wernicke's aphasia with the effects of right hemisphere damage added to it. The subject at times might not be able to move a complete body hemisphere or be under hemiplegia. (Springer and Deutsch 1993, 153-55)

In the book *Introduction to Aphasia, Handbook of Neurological Speech and Language Disorders* (Kirshner, 1998), the author mentions that the process of recognition of audio starts with the ears, or in other words, the auditory pathway starts with the ears. The eight cranial nerves convey the signal to the area 41 and 42 of Broadman's area, which are further responsible for analysing the signals. The Heschls gyri is located on the superior surface of the superior temporal gyrus, which in turn is buried inside the sylvian fissure. Similarly the visual cortex is responsible for the visual pathway. The primary visual area is called the striate cortex. The posterior areas of the left hemisphere are responsible for processing sensory information into language, and the right hemisphere, specifically the Exner's area. Speech also involves the Basal ganglia, which is also responsible for motor activity in the body. The thalamus of the brain acts like a relaying centre which sits above the diencephalon and since it contains motor relay units, it sends the sensory information to the Wernicke's area and Broadman's area 39, which in turn is believed to be responsible for associating information from various sensory streams. (Kirshner, Howard S, 1998)

The right hemisphere activation levels are high while a person is reading a story, listening to a conversation or even listening to a talk passively. The imaging machines have let us to an understanding that the left hemisphere is not enough to listen and understand discourses. Participants without any sort of brain damage had been tested at labs and it was found out that the right hemisphere had more lit up sections during making discourses and listening to talks than the left hemisphere. The temporal lobe activity has been lateralized in the right hemisphere highly and this proves that the right hemisphere is responsible for an understanding in discourses. On being asked "Can you open the door for me", a typical RHD patient would answer in 'yes' or 'no' because they have lost the ability to understand the pragmatic reference of the question being asked but a subject without any brain damage would easily understand the meaning such a question and open the door for the person asking the question. Participants with RHD do not have the ability to differentiate between the literal meaning of the question and the real meaning of the question asked, with reference to the situation because we know that they have lost the ability to use the right hemisphere in communication and they cannot recall the other meanings of the words being used in the question. According to Tim J Crow and Rachel L C. Mitchell, the right brain is necessary for humans to comprehend discourses. (Rachel and Crow, 2005, 963-78)

Subjects with damage to the right hemisphere of the brain can be affected with hemiplegia or hemiparesis, depending on the level of damage. As mentioned in the book, Introduction to Neurolinguistics (Ahlsen, 2006, pp 6), subjects with damage to the right hemisphere of the brain can be suffering from left hemisphere neglect, even if their left side of the body is still under their control. Depending on the level of damage, subjects lose ability to participate in discourses properly and the ability to comprehend metaphors, imageries, sarcasm, humor and emotional prosody. The paper *Beyond the right hemisphere: brain mechanisms mediating vocal emotional processing* (Schirmera, Kotzb, 2006, pp 24-30) states that the right hemisphere of the brain is responsible for judging emotions in speech and moods in speech. This ability of the right brain is an asset to the process of evolution in the human race. Acoustic cues like, frequency of voice and range of voice and temporal movements are analysed by the right hemisphere of the brain.

Strokes to the left hemisphere of the brain might cause problems in the language faculty of a human being and the same to the right hemisphere of a human being might disrupt orientation, theme understanding, discourse understanding and the overall understanding of metaphors and sarcasms and so on. Aphasia might follow any kind of stroke to the left hemisphere damaging either the Broca's area or the Wernicke's area, respectively in the frontal lobe and the temporal lobe. Stroke to any other place might cause no speech disorder but might cause apraxia or hemiplegia of the right hemisphere. (Ahlsen, 2006, p. 17)

A case study of 12 patients was carried out by Vaishna Narang as described in her book (Narang, 2009, p. 93) on 12 native Punjabi speakers who were affected by stroke. This study tested participants for the lexical level, sentence level and discourse level of communication. The study was conducted to understand the effect of stroke in LHD and RHD participants in comparison with normal controls in the lexical, sentence and discourse level. The results of the sentence level of study revealed that RHD subjects were most affected while either comprehending tones or pitch levels in a sentence or producing tones and pitch when compared with normal controls, in a sentence.

Praat is a software which can be used (Praat: Home, 2015) to find out formants, pitch, intensity and other acoustic data from sound files while working with phonological data. Praat can also be used to segment sounds, de-noise sound files and to monitor sound spectrograms for further analysis. Other tools like palatography and electropalatography can help understand the active and passive articulators and the exact regions of articulation.

Agniva Pal's (2016) unpublished M.Phil. thesis on Language and Speech of the RHD, presents the study 18 right hemisphere damaged participants in comparison with their age and gender matched normal controls. It studies the deviations at the level of discourse, frequency at the level of sentences and vowels as used in words at the level of speech. At the level of discourse it studied the duration of discourse, the fluency in discourse, comprehension and digressions in speech. It included some personal and subjective views from the researcher regarding the facial expressions and emotional quotients. At the level of sentences, it studied the fundamental frequency as a measure for pitch levels in declarative sentences for continuous

speech. It studied fluency in discourse by manually calculating the number of words spoken per minute. It was found out that RHD participants have much lesser fluency rates in comparison with the control group participants. At the level of vowels as in words. The acoustic space of vowels in cases of RHD and Controls was studied in detail using all peripheral vowels in the Bengali language. It is interesting to note that in some cases the acoustic space of vowels was reduced to as small as 9%, 13%, 23%, 43% to 70% and 90%. In the cases with more than 70% acoustic space, the deviations were not audible without tools and instruments. It is also important to notice that no major difference was found between the RHD group and the control group in terms of vowel duration.

The Glasgow Coma scale is a test, which can be administered only by clinical persons on patients and participants to understand the extent of coma. GCS can actually help a researcher understand how terminally ill a participant is. The scores are distributed as such: Eye (4), Verbal (5), and Motor (6). The maximum score is 15. A score of under 11 is considered critical. A score under 8 is considered fatal. A score under 15 needs urgent attention and care. (Glasgow Coma Scale/Score (GCS), 2017) The NIMHANS neurophysiological battery serves a similar purpose. (Rao SL, Subhakrishnan DK, Gopulkumar K, 2004)

The Mini Mental State Examination or MMSE is a very common way to test problems of memory loss and other related mental abilities. It lets a researcher understand if an individual is suffering from dementia or not. Prior medical records of a person can further substantiate the results of an MMSE exam. There are various questions in an MMSE exam, the full marks being 30. A score of 27 or more is expected from undamaged individuals with no dementia. There is a hindi version of the MMSE exam available in India called the Hindi Mental State Examination (Ganguli et all, 1993). (The MMSE test, 2017)

3. Research Methodology

The present study is a neurolinguistic study, which uses tools and methodologies from general linguistics as well as neurolinguistics. The present research uses audio recordings to find out the fluency rates in Bangla speaking cases of Right Hemisphere Damage through the use of Praat to playback the recordings. At the level of discourse, the participants were required to

listen to two short stories and then narrate the same story back to the researcher, being as close to the original story as possible. At the level of sentences the participants were asked to read out a list of 9 sentences.

Linguistic fieldwork requires the researcher to make the participants feel comfortable. It is absolutely a necessity that the participants feel normal and stable for the researcher to record unbiased opinions, recordings or videos. If the participant is not speaking the way he or she speaks normally, it would entail some prejudice in the data for that research. It can skew the entire data of the research. (Max Planck, 11) If the participant is from a tribal community or from an extremely backward region, he or she must be made to feel comfortable. A working rapport with the participant and the researcher can ease up the process of data collection largely.

3.1. Participant Selection

Preferably, monolingual Bangla speaking participants who have damage to the right hemisphere of the brain, have been selected. Controls chosen are generally members of the same family with age and gender matching. In case no one from the same family was available for the research according to the parameters mentioned above, age and gender matched control participants were chosen from the same socio- economic background.

3.2. Inclusion And Exclusion Criteria

Primarily, the research data elicitation began with random sampling. The inclusion criteria had been set after a few random samplings. The Mini Mental State Exam ensured the current state of the participants, both RHD and healthy participants, and a score of 25-30 would ensure, that they are not suffering from any other sort of disorders which might sabotage the data. The Glasgow Coma Scale with a score of at least 11 would also ensure similar levels of severity of all participants and that no participant is under coma, which might sabotage the data. The exclusion criteria would make sure that participants in the ICU, or participants with extreme disabilities would not be selected. The other criteria have been determined after the random sampling phase.

3.3. Ethical Clearance

Any research involving human participants, being conducted by JNU students, requires an ethical clearance from the JNU Institutional Ethics Review Board (IERB). A detailed description of the research proceedings and the involvement details of the participants have to be submitted to the JNU IERB while presenting one's research proposal to receive ethical clearance. The ethical clearance for the present research, granted by IERB, JNU is attached in the appendix. For working with human participants, other than being granted an ethical clearance from JNU IERB, a researcher also needs a PIS ICF form. When a participant agrees to provide information for a certain research, he or she has to sign a form with detailed information about the research (including information like a brief introduction, research objectives, nature of involvement of the subjects and how the information will be used).

3.4. Field Study

To acquire a steady flow of participants, Bangur Institute of Neurosciences, Kolkata was approached. Dr, Goutam Ganguly, from the above-mentioned institute, was requested to help with the present research. The participant selection procedure, according to the inclusion and exclusion criteria, have all taken place under his supervision. Participants have been documented in details. A specific format for documenting participants was created and used. Such forms for all participants have been filled with details of the subject like the place of lesion or lesions, the time post incidence, the present condition, the symptoms and so on. In the primary information section, name, age and gender of the subjects have also be documented, although this is purely for documenting the data and related purposes. The names of the participants have not been used in the present research; instead codes have been used.

3.5. Coding Participants

Participants have been coded according to the following table:

Serial number	Name initials	Age	Gender	R / C
00	AB	50	M	R
01	AC	55	F	C

The above table explains the process of coding the names for the participants in the present study. The unique serial number for every participant is an 8 digit code. The first two digits are allotted according to alphabetical order of the participants. The initials of the name have engaged the next two digits. The next two digits have been used by the age followed by a single digit for gender. The last digit is either R (signifying RHD) or C (signifying controls). For example 00AB50MR, 01AC55FC as stated in the table above.

3.6. Tools and Instruments

This section houses all the various tools, either technical or linguistic. Linguistic research requires recording equipment and softwares. Linguistic research requires the ability to transcribe spoken speech for further analysis using various softwares like Praat, Goldwave and Elan. Praat for Mac and Windows (Boersma, 2001) has been used for playing back the recordings. Praat is a free software for analyzing and doing phonetics on personal computers. (Praat: Home, 2015)

Microsoft Excel was primarily used to save the primary data after being processed from Praat. Microsoft Excel, a program based on spreadsheets helps in creating the charts necessary to compare two groups of data. (Excel: Create Order, 2015)

The main research has been written with the help of Microsoft Word. Microsoft Word is an efficient document handling program. (Word: Write On, 2015)

Primary recording has been conducted with a ZOOM H1 field recorder. It is a handy microphone with functions like low cut and PCM lossless recording formats.

The fluency rates in discourse have been found by following th following set of processes:

1. Record the stories and 9 sentences from the participants.
2. Open the files in Praat, separately.
3. Play back the discourse recording.
4. Count the number of words spoken by the participants in the total discourse recording.

5. Find out the number of words spoken by all participants in one minute.
6. Calculate the amount of time taken by the participants to complete the recording.
7. Calculate the time taken to read out 9 sentences.
8. Note down the relevant fluency figures and times in MS Excel.
9. Create table and graph with the info.

3.7. The Stories

The following stories were narrated to the participants in Bangla.

The Hart and the Hunter

The Hart was once drinking from a pool and admiring the noble figure he made there. "Ah," said he, "where can you see such noble horns as these, with such antlers! I wish I had legs more worthy to bear such a noble crown; it is a pity they are so slim and slight."

At that moment a Hunter approached and sent an arrow whistling after him.

Away bounded the Hart, and soon, by the aid of his nimble legs, was nearly out of sight of the Hunter; but not noticing where he was going, he passed under some trees with branches growing low down in which his antlers were caught, so that the Hunter had time to come up. "Alas! Alas!" cried the Hart: "We often despise what is most useful to us"

The Frogs Desiring a King

A few frogs lived happily in a marshy swamp that was perfect but then they started to look for a king who would rule them. They prayed to God to give them a king. God sent them a big block of wood and it fell right into the marsh. At first, they were afraid of its size but then they slowly got used to it and realized it was not moving. They finally, climbed to the top of it and conquered their king. They prayed to God again, this time asking for a live king who would actually rule over them. Now this made Jove angry, so he sent among them a big Stork that soon set to work gobbling them all up.

Then the Frogs repented when too late.

4. Case Study

This section displays important information about every RHD participant. It primarily provides primary information about the female RHD participants. This section primarily begins with the codified name, followed by the control participant the RHD participant is being compared with. It also includes the MMSE and GCS scores, the time post incidence and a short description of the condition of the participant. The area of damage in the brain follows the above-mentioned sections.

4.1. CASE STUDY 1

PRIMARY INFO

Codified Name: 22CS62FR

Female, 62 years of age, at the time of recording and case study.

Age and gender matched control: 03NS64FC

Time since incidence: 1 months post incidence, at the time of recording.

PARTICIPANT INFORMATION

Condition of participant: The participant was fully conscious, having scored more than 11 on the GCS. She also scored 27 on the MMSE.

The speech of the participant was slightly slurred but was understandable. The total loudness of her speech went down, according to her family members.

The doctor also performed a test in which he held both her hands in his hands and then asked her to keep them where he is holding them, after he lets her hands go. She could maintain the position, but her left hand fell a fair bit, before she regained control. According to the doctor, these are subtle signs of the stroke to the right hemisphere.

Observations made by doctor: The doctor mentions that she has no agraphia, no dementia, as well as no alexia. Participant is not hypertensive.

Region of damage: A small sub-acute ischemic infarct at right capsule-thalamic region.

4.2. CASE STUDY 2

PRIMARY INFO

Codified Name: 23GD65FR

Female, 65 years of age, at the time of recording and case study.

Age and gender matched control: 03NS64FC

Time since incidence: approximately 6 months post incidence, at the time of recording.

PARTICIPANT INFORMATION

Condition of participant: The participant was fully conscious, having scored more than 11 on the GCS. She also scored 28 on the MMSE.

The speech of the participant was not slurred and was completely understandable. The total loudness of her speech went down, according to her family members and could be noticed while making conversations with her, as well as the recording sessions.

The family of the participant assured that she was facing no problems in eating.

The doctor also performed a test in which he held both her hands in his hands and then asked her to keep them where he is holding them, after he lets her hands go. She could maintain the position, but her left hand fell a fair bit, before she regained control. According to the doctor, these are subtle signs of the stroke to the right hemisphere.

Observations made by doctor: The doctor mentions that she has no agraphia, no dementia, as well as no alexia. Participant is hypertensive.

Region of damage: An acute lacunar infarct at the right parietal lobe.

4.3. CASE STUDY 3

PRIMARY INFO

Codified Name: 24NB50FR

Female, 50 years of age, at the time of recording and case study.

Age and gender matched control: 06RB56FC

Time since incidence: approximately 4 months post incidence, at the time of recording.

PARTICIPANT INFORMATION

Condition of participant: The participant was fully conscious, having scored more than 11 on the GCS. She also scored 26 on the MMSE.

The speech of the participant was slightly slurred, due to left hemiparesis, but was understandable.

On being asked to name colors, she could name them correctly.

The doctor also performed a test in which he held both her hands in his hands and then asked her to keep them where he is holding them, after he lets her hands go. She could maintain the position of the right hand, but her left hand fell down. She kept trying, but she could barely move her left hand.

Observations made by doctor: The doctor mentions that she has no agraphia, no dementia, as well as no alexia. Participant is hypertensive.

Region of damage: Haemorrhage in the right basal ganglia.

4.4. CASE STUDY 4

PRIMARY INFO

Codified Name: 25UG58FR.

Female, 58 years of age, at the time of recording and case study.

Age and gender matched control: 07SB60FC

Time since incidence: approximately 1 year post incidence, at the time of recording.

PARTICIPANT INFORMATION

Condition of participant: The participant was fully conscious, having scored a perfect 15 on the GCS. She also scored 29 on the MMSE.

The speech of the participant was not slurred, and was completely understandable.

She mentioned that she has no problems in eating.

The doctor also performed a test in which he held both her hands in his hands and then asked her to keep them where he is holding them, after he lets her hands go. She could maintain the position of both the hands.

Observations made by doctor: The doctor mentions that she has no agraphia, no dementia, as well as no alexia. Participant is not hypertensive. Participant does not have enough loudness in speech and has minimal expressions while conversing.

Region of damage: Massive infarct at the right basal ganglia.

Analysis and Discussion

In this section, we will take a look at the fluency rates of the participants in the discourse recordings and then compare the time they took to complete reading out 9 sentences. We shall do the comparisons in a tabulated form, followed by graphical representations. We shall compare the following variables (along with their abbreviations) in the following tables and graphs:

1. S1 TW – Total number of words spoken by a participant in the whole discourse recording in story 1
2. S2 TW – Total number of words spoken by a participant in the whole discourse recording in story 1
3. S1 WPM – The number of words spoken per minute in story 1
4. S2 WPM – The number of words spoken per minute in story 2
5. COM TW – Total words spoken by participants in combined mean of two stories – Combined mean of the two stories
6. COM WPM – The number of words spoken in a minute by participants in the combined mean of two stories
7. MEAN TIME – The total amount of time taken to complete the discourse recording

22CS62FR	22CS62FR						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	98	66	81	60	89	63	85
07SB60FC	07SB60FC						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	163	102	102	120	136	111	74
23GD65FR	23GD65FR						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	104	156	70	162	87	159	33
03NS64FC	03NS64FC						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	178	144	118	120	146	132	67
24NB50FR	24NB50FR						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	104	156	106	168	105	162	39
04ND51FC	04ND51FC						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	208	150	161	156	185	153	73
25UG58FR	25UG58FR						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	74	96	82	120	78	108	44
06RB56FC	06RB56FC						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	118	120	135	114	127	117	65
MEANFR	MEANFR						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	95	119	85	128	90	123	50
MEANFC	MEANFC						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	167	129	129	128	148	128	70
NARRATOR	NARRATOR						
	S1 TW	S1 WPM	S2 TW	S2 WPM	COM TW	COM WPM	MEAN TIME
	182	**156**	**157**	**168**	**174**	**166**	**63**

Table 1: A table comparing the fluency rates of the participants along with the total time taken for the narration of the stories

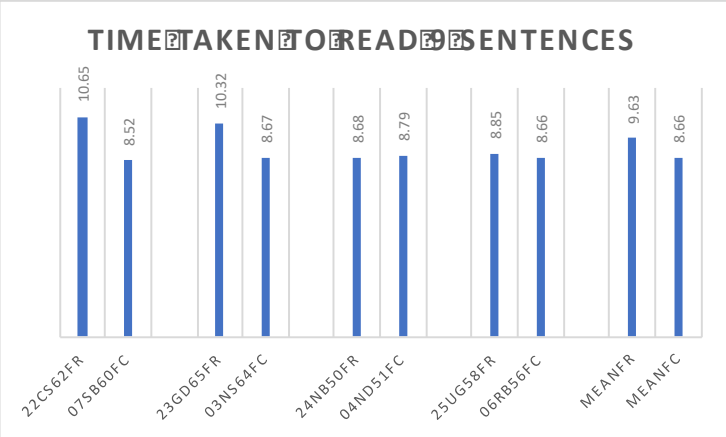

Fig 1: Figure showing the time taken to read all the 9 sentences; comparing RHD participants and control participants.

We can discern the following from table 1 and figure 1 above:

1. The original story 1 had 182 words and the original story 2 had 168 words. The NARRATOR read out the stories to all the participants, hence used exactly the same number of words every time while narrating the stories.

2. MEANFR has narrated the first story in 95 words compared to MEANFC, who used 167 words. The original story 1 contained 182 words in comparison. MEANFR has a fluency rate of 119 wpm in the first story while MEANFC has a fluency rate of 129 words per minute.

3. MEANFR has narrated the second story in 85 words compared to MEANFC, who used 129 words. The original story 2 contained 157 words in comparison. MEANFR has a fluency rate of 128 wpm in the second story, while MEANFC has a fluency rate of 128 words per minute.

4. MEANFR has used a total of 90 words in the mean of the two stories in comparison with MEANFC, who used 148 words. The mean of the original two stories contained 174 words in comparison. MEANFR has a fluency rate of 123 wpm in the mean of the two stories and took 50 seconds to complete narrating, while MEANFC has a fluency rate of 128 words per minute and took 70 seconds to complete narrating.

5. MEANFR took 9.63 seconds to complete reading out 9 sentences while MEANFC took 8.66 seconds to read out the 9 sentences.

6. 22CS62FR has narrated the first story in 98 words compared to 07SB60FC, who used 163 words. The original story 1 contained 182 words in comparison. 22CS62FR has a fluency rate of 66 wpm in the first story while 07SB60FC has a fluency rate of 102 words per minute.

7. 22CS62FR has narrated the second story in 81 words compared to 07SB60FC, who used 102 words. The original story 2 contained 157 words in comparison. 22CS62FR has a fluency rate of 60 wpm in the second story, while 07SB60FC has a fluency rate of 120 words per minute.

8. 22CS62FR has used a total of 89 words in the mean of the two stories in comparison with 07SB60FC, who used 136 words. The mean of the original two stories contained 174 words in comparison. 22CS62FR has a fluency rate of 63 wpm in the mean of the two stories and took 85 seconds to complete narrating, while 07SB60FC has a fluency rate of 111 words per minute and took 74 seconds to complete narrating.

9. 22CS62FR took 10.65 seconds to complete reading out 9 sentences while 07SB60FC took 8.52 seconds to read out the 9 sentences.

10. We can notice slower and shorter speech in 22CS62FR in comparison with the 07SB60FC.

11. 23GD65FR has narrated the first story in 104 words compared to 03NS64FC, who used 178 words. The original story 1 contained 182 words in comparison. 23GD65FR has a fluency rate of 156 wpm in the first story while 03NS64FC has a fluency rate of 144 words per minute. It's important to notice that in spite of having a higher fluency rate in the RHD participants' recording, the control participant has a higher number of total words used in the discourse.

12. 23GD65FR has narrated the second story in 70 words compared to 03NS64FC, who used 118 words. The original story 2 contained 157 words in comparison. 23GD65FR has a fluency rate of 162 wpm in the second story, while 03NS64FChas a fluency rate of 120 words per minute. Again, it should be noted that the RHD participant has used less number of total words in the narration of the second story.

13. 23GD65FR has used a total of 87 words in the mean of the two stories in comparison with 03NS64FC, who used 146 words. The mean of the original two stories contained 174 words in comparison. 23GD65FR has a fluency rate of 159 wpm in the mean of the two stories and took 33 seconds to complete narrating, while 03NS64FC has a fluency rate of 132 words per minute and took 67 seconds to complete narrating.

14. 23GD65FR took 10.32 seconds to complete reading out 9 sentences while 03NS64FC took 8.67 seconds to read out the 9 sentences.

15. We can notice much slower speech in 23GD65FR in comparison with the 03NS64FC, even though the average number of words spoken in the discourse recordings by the RHD participant is higher, because of much shorter length of the recordings.

16. 24NB50FR has narrated the first story in 104 words compared to 04ND51FC, who used 208 words. The original story 1 contained 182 words in comparison. 24NB50FR has a fluency rate of 156 wpm in the first story while 04ND51FC has a fluency rate of 150 words per minute. It's important to notice that in spite of having a marginally higher fluency rate in the RHD participant, the control participant has a higher number of total words used in the discourse.

17. 24NB50FR has narrated the second story in 106 words compared to 04ND51FC, who used 161 words. The original story 2 contained 157 words in comparison. 24NB50FR has a fluency rate of 168 wpm in the second story, while 04ND51FC has a fluency rate of 156 words

per minute. Again, it should be noted that the RHD participant has used less number of total words in the narration of the second story, in spite of having a higher fluency rate.

18. 24NB50FR has used a total of 105 words in the mean of the two stories in comparison with 04ND51FC, who used 185 words. The mean of the original two stories contained 174 words in comparison. 24NB50FR has a fluency rate of 162 wpm in the mean of the two stories and took 39 seconds to complete narrating, while 04ND51FC has a fluency rate of 153 words per minute and took 73 seconds to complete narrating.

19. 24NB50FR took 8.68 seconds to complete reading out 9 sentences while 04ND51FC took 8.79 seconds to read out the 9 sentences.

20. We can notice much slower speech in 24NB50FR, in comparison with 04ND51FC, even though the average number of words spoken in the discourse recordings by the RHD participant is higher, because of much shorter length of the recordings.

21. 25UG58FR has narrated the first story in 74 words compared to 04ND51FC, who used 118 words. The original story 1 contained 182 words in comparison. 25UG58FR has a fluency rate of 96 wpm in the first story while 04ND51FC has a fluency rate of 120 words per minute.

22. 25UG58FR has narrated the second story in 82 words compared to 06RB56FC, who used 135 words. The original story 2 contained 157 words in comparison. 25UG58FR has a fluency rate of 120 wpm in the second story, while 06RB56FC has a fluency rate of 114 words per minute. It should be noted that the RHD participant has used less number of total words in the narration of the second story, in spite of having a higher fluency rate.

23. 25UG58FR has used a total of 78 words in the mean of the two stories in comparison with 06RB56FC, who used 127 words. The mean of the original two stories contained 174 words in comparison. 25UG58FR has a fluency rate of 108 wpm in the mean of the two stories and took 44 seconds to complete narrating, while 06RB56FC has a fluency rate of 117 words per minute and took 65 seconds to complete narrating.

24. 25UG58FR took 8.85 seconds to complete reading out 9 sentences while 06RB56FC took 8.66 seconds to read out the 9 sentences.

25. 25UG58FR has lesser number of total words in both the stories in spite of having a higher fluency rate in story 2. The RHD participant also completed the stories much faster than 06RB56FC.

26. In story 1, 25UG58FR, has the minimum number of total words at 74, whereas 23GD65FR and 24NB50FR have the maximum number of total words at 104.

27. In story 2, 23GD65FR, has the minimum number of total words at 70, whereas 24NB50FR has the maximum number of total words at 106.

28. 23GD65FR has a mean time of 33 seconds in the discourse recordings, which is the minimum time, and the maximum time belongs to 22CS62FR at 85 seconds.

After comparing the actual values, based on the table displayed previously, we can see a marked difference in the total number of words used in a discourse by the RHD group in comparison with the control group and the amount of times needed to narrate the stories. The RHD group takes much lesser time to narrate the stories and has a fluency rate which is almost equal to that of the control group. It is spoken for much lesser times in comparison with the control group and have much lesser total word counts.

The following chart compares MEANFR and MEANFC to NARRATOR in terms of percentage. The chart marks the percentage MEANFR and MEANFC have scored out of the scores of the NARRATOR.

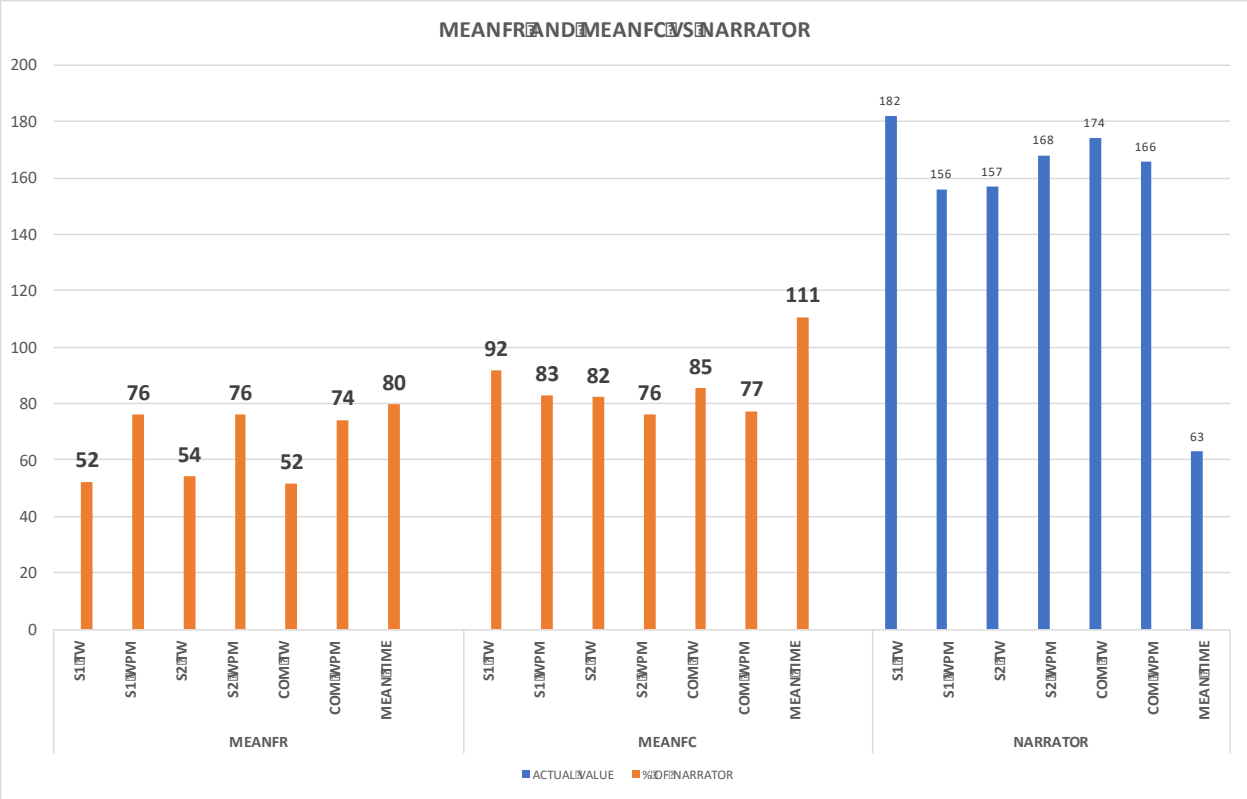

Fig 2: A bar graph comparing MEANFR with MEANFC and NARRATOR.

We can discern the following from the graph above:

1. The NARRATOR has a total word count of 182 in story 1 and MEANFR has fulfilled only 52% of that while MEANFC has fulfilled 92% of that, which is very close to the original.

2. The NARRATOR has a total word count of 157 in story 2 and MEANFR has fulfilled only 54% of that while MEANFC has fulfilled 82% of that, which is close to the original, but closer than story 1.

3. The NARRATOR has a total word count of 174 in the mean of the two stories and MEANFR has fulfilled only 52% of that while MEANFC has fulfilled 85% of that, which is very close to the original. We can note that the RHD group has scored a bit over half of the total word count of the NARRATOR, while the control group mean has scored 85% which is pretty near to the word count of the NARRATOR.

4. In the combined mean of the time taken to narrate the two stories, the NARRATOR took 63 seconds and MEANFR has fulfilled only 80% of that while MEANFC has fulfilled 111% of that.

To know the whole extent of damage of the individual RHD case studies, we also need to compare the total words and words per minute figures of the individual RHD participants with the mean of the control group and the narrator. The following bar graph compares the same:

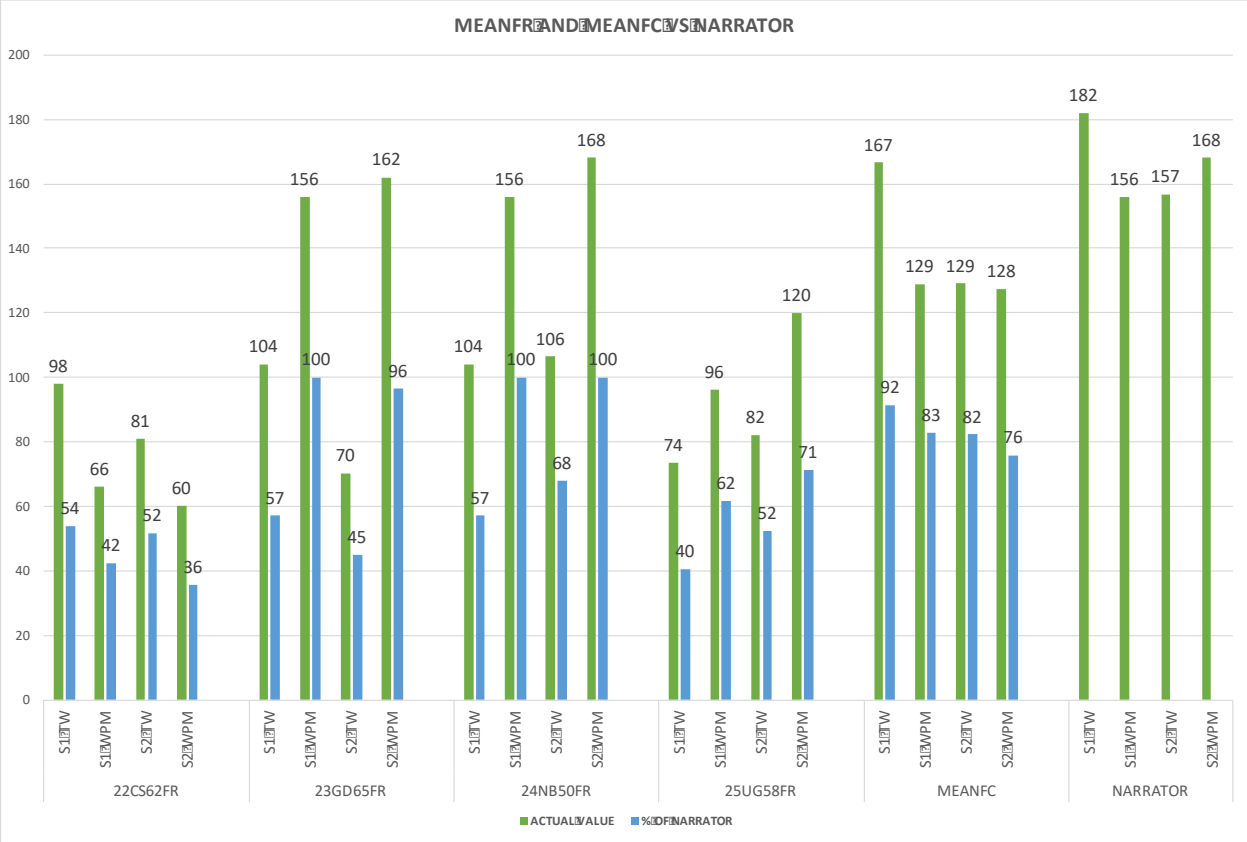

Fig 3: A bar chart comparing the individual RHD participants to MEANFC and NARRATOR.

In reference with the damage mentioned in the individual case studies mentioned previously, we can discern the following from figure 3:

1. 22CS62FR spoke 98 words in the first story, which is only 54% of what the narrator spoke, and is only a bit higher than half of what the narrator spoke. 22CS62FR spoke 81 words in the second story, which is 52% of what the narrator spoke. 22CS62FR has a consistently low total word rate. She also has low 'words per minute' figures at 42% of the narrator in story 1 and 36% of the narrator in story 2. 22CS62FR suffered a stroke 1 month back from when she was recorded. She has a small subacute ischemic infarct at the right capsule-thalamic region. Her case

study also mentions that she has slightly slurred speech and is not very loud to the ears. According to the graph, she is the one with the minimum total words and words per minute rate.

2. 23GD65FR spoke 104 words in the first story, which is only 57% of what the narrator spoke. 23GD65FR spoke 70 words in the second story, which is 45% of what the narrator spoke and is lesser than half. But 23GD65FR has a consistently high rate of 'words per minute' at 100% of the narrator in story 1 and 96% of the narrator in story 2. 23GD65FR suffered a stroke 6 month back from when she was recorded. She has a lacunar infarct at the right parietal lobe. Her speech was not slurred but she was less loud than normal participants. According to the graph, she seems closer to the narrator than 22CS62FR and 25UG58FR.

3. 24NB50FR spoke 104 words in the first story, which is only 57% of what the narrator spoke. 24NB50FR spoke 106 words in the second story, which is 68% of what the narrator spoke. But 24NB50FR has a very consistently high rate of 'words per minute' at 100% of the narrator in story 1 and 100% of the narrator in story 2. 24NB50FR suffered a stroke 4 month back from when she was recorded. She has a haemorrhage in the right basal ganglia. The participant was under left hemiparesis and had slight slurring but was easily understandable and was loud enough to be heard normally. According to the graph, she seems closer to the narrator than 22CS62FR and 25UG58FR.

4. 25UG58FR spoke 74 words in the first story, which is only 40% of what the narrator spoke. 25UG58FR spoke 82 words in the second story, which is 52% of what the narrator spoke. Both the figures are very low. 25UG58FR has a 'words per minute' figure which is at 62% of the narrator in story 1 and 71% of the narrator in story 2. 25UG58FR suffered a stroke 1 year back from when she was recorded. She has an infarct at the right basal ganglia. The participant could walk and talk normally without any sort of slurring but was not very loud.

Conclusion

22CS62FR who was recorded 1 month post incidence has been noted to be the most severe case. Perhaps being recorded 1 month post incidence took a toll on both the total words and words per minute figures. In comparison to her, 24NB50FR, who was recorded 4 months post incidence, has a fluency rate of 156 wpm in story 1 and 168 wpm in story 2, which is exactly the same as the NARRATOR. Even though 24NB50FR was affected with hemiparesis in the first one month, she has healed faster and it is also possible that her level of damage was less

severe. 23GD65FR also has similar figures as 24NB50FR and has fluency rates, which are almost the same as that of the NARRATOR. She was recorded 6 months post incidence and we can, hence, notice the time factor and that she has healed. 25UG58FR on the other hand, was recorded 1 year post incidence but still has a low total word count. It is also mentioned in the case study that the loudness in her voice was too low. Here, it should be noted that she suffered two strokes in a time of one week, at the time of incidence. It is probable that in spite of getting a year time to heal, she has not considerably healed because of massive damage. It can also be possible that she has acquired a style of speaking in which she uses less words and speaks less loudly. If we have to place the cases on a scale of severity we can say that the most severe case among the abovementioned case is 22CS62FR, followed by 25UG58FR, followed by 23GD65FR and finally 24NB50FR.

We can hence see that RHD participants in spite of having normal rates of speaking, actually speak much lesser number of words as compared to the normal controls at the level of discourse. If an RHD participant and a normal individual have to explain something, it has been noted that the RHD participant uses lesser words and takes much lesser time to explain the concept while a normal individual would take their time to explain the thing properly, using more words. A general trend here is that RHD participants hurry to finish speaking, as fast as they can, using lesser number of words to complete speaking.

Here, it should also be noted that the reason for the narrator having a much higher fluency figure than the RHD group and the control group is that the narrator conveniently read the stories out from a paper and did not have to remember the stories, like the other participants.

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References

Mark Jung Beeman, C. C. (1997). *Right Hemisphere Language Comprehension: Perspectives From Cognitive Neuroscience.* Mahwah, New Jersey: Psychology Press.

Myers, P. S. (1999). *Right hemisphere damage — Disorders of communication and cognition.* London: Singular Publishing Group.

Grice, H. (1975). *"Logic and Conversation," Syntax and Semantics.* Academic Press.

Praat: Home. (2015, March 4). Retrieved from Praat: doing phonetics by Computer: http://www.fon.hum.uva.nl/praat/

Glasgow Coma Scale/Score (GCS). (2017, Feb 11). Retrieved from MD CALC: https://www.mdcalc.com/glasgow-coma-scale-score-gcs

The MMSE test. (2017, Feb 11). Retrieved from Alzheimer's Society: https://www.alzheimers.org.uk/info/20071/diagnosis/97/the_mmse_test
Max Planck. (11, Feb 2017). Retrieved from Typological tools for field linguistics: https://www.eva.mpg.de/lingua/tools-at-lingboard/tools.php
Boersma, P. a. (2001). Praat, a system for doing phonetics by computer. 341-345.
Excel: Create Order. (2015, March 4). Retrieved from Products: Office: https://products.office.com/en-us/excel
Word: Write On. (2015, March 4). Retrieved from Products: Office: https://products.office.com/en-us/word
Goldwave Home. (2015, May 26). Retrieved from Goldwave: www.goldwave.com/
Caroline Gordon, R. L. (1987, August 15). Dysphagia In Acute Stroke. *ritish Medical Journal (Clinical Research Edition), 295*(6595), 411-14.
Kirshner, H. S. (1998). *Introduction to Aphasia, Handbook of Neurological Speech and Language Disorders.* Academic Press.
Behrens, S. (1989). Characterizing sentence intonation in a right hemisphere-damaged population. *Brain and Language*, 181-200.
Ahlsen, E. (2006). *Introduction to Neurolinguistics.* Amsterdam / Philadelphia: John Benjamins Publishing Company.
Narang, V. (2009). *Communication Disorders: Studies on Aphasia, Acalculia and Dysarthria* . New Delhi: Academic Excellence.

Ropper, Allan H. "Severe dysarthria with right hemisphere stroke." *Neurology* 37.6 (1987): 1061-1061.

Rachel L. C. Mitchell, T. J. (2005). Right hemisphere language functions and schizophrenia: the forgotten hemisphere? *Brain*, 963-978.
Sally P Springer, G. D. (1993). The Concept of Cerebral Dominance. In G. D. Sally P Springer, *Left Brain Right Brain* (p. 13). New York: W.H. Freeman and Company.
T.J. Crow, L. C. (1998, December). Relative hand skill predicts academic ability: global deficits at the point of hemispheric indecision . *Neuropsychologia, 36*(12), 1275-82.

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