ABSTRACT

Comparison of Narrative Discourse Production Using Correct Information Units (CIUs) in Individuals with Unilateral Brain Damage

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The aim of this study is to compare the narrative discourse production differences in adults with right hemisphere damage (RHD) and aphasia resulting from left hemisphere damage, using measures of CIUs (total # CIUs, CIUs/Minute, and %CIUs) to better understand the language difficulties experienced by individuals with unilateral brain damage on both the microlinguistic and macrolinguistic levels of discourse. We hypothesize that individuals with aphasia will perform lower on all measures of CIUs analyzed compared to individuals with RHD. To test this hypothesis, narrative discourse samples of 15 aphasic individuals and 15 individuals with RHD from the TalkBank Database were analyzed using CLAN. Results from this analysis show that individuals with aphasia performed lower on all measures of CIUs, indicating that their narrative discourse performance was poorer, less accurate, relevant, informative, and on topic, compared to the individuals with RHD.

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COMPARISON OF NARRATIVE DISCOURSE PRODUCTION USING CORRECT INFORMATION UNITS (CIUS) IN INDIVIDUALS WITH UNILATERAL BRAIN DAMAGE

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TABLE OF CONTENTS

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CHAPTER ONE

Introduction

Role of the Left Hemisphere in Language Production

The left hemisphere is the language dominant hemisphere in most individuals, as it contains many of the language-specific areas of the brain needed for speech production and comprehension (Long and Baynes, 2002). For this reason, damage to these structures, often caused by strokes, can result in serious and obvious language deficits impacting speech, reading, writing, and comprehension (Price et al, 2010). These deficits are an acquired language disorder referred to as aphasia (Price et al, 2010). Aphasia affects an estimated one third of people who have strokes (Sheppard & Sebastian, 2020). There are many types of aphasia, as well as degrees of severity. Types of aphasia, as defined by the Boston classification system include Broca's, Wernicke's, Conduction, Anomic, Transcortical Motor, Transcortical Sensory, Global, and Mixed (Sheppard & Sebastian, 2020). Similarly, lesion site and size can impact the severity and appearance of aphasia (Yu et al, 2017).

Those with aphasia struggle with defined and unique language deficits depending on the type and severity, but their cognition has shown to stay intact in most cases (Pallickal and Hema, 2020). In general, aphasia tends to affect language on the microlinguistic level (Karaduman et al, 2017). This level of discourse deals with sentence level and word level processing (Pallickal and Hema, 2020). As a result, many people with aphasia resulting from left hemisphere damage have difficulties with syntactic organization and processing, word finding, phonological processing, syntactic

complexity, and cohesion (Pallickal and Hema, 2020; Karaduman et al, 2017). This may lead to overall shorter, less complex, and less specific language (Karaduman et al, 2017). These deficits are typically pronounced enough to be apparent in many forms of language production since all language production relies on these basic language skills.

Role of the Right Hemisphere in Language Production

The right hemisphere is less directly related to language, though it "appears to process language to some extent" (Long and Baynes, 2002). The right hemisphere houses structures that deal with many different cognitive skills such as suppressing insignificant information, organization of information, staying on topic, and paying attention (Minga et al, 2021). For this reason, language difficulties following damage to the right hemisphere are believed to be cognitively based (Minga et al, 2021). Though the right hemisphere is not seen to be as important in language production as the left hemisphere, these cognitively based deficits can greatly impact language, especially on the macrolinguistic level, which looks at the effectiveness and connectedness of discourse as a whole (Karaduman et al, 2017).

This level requires integration of many different cognitive, pragmatic, and language skills (Minga et al, 2021). When there is a breakdown in any of these areas after damage to the right hemisphere, discourse production suffers (Minga et al, 2021). People with right hemisphere damage (RHD), as a result, tend to produce discourse that is less efficient, disorganized, off topic, and even inappropriate (Minga et al, 2021). Due to the complex nature of these language skills, compared to the more obvious deficits in individuals with left hemisphere damage, much less is understood about the linguistic deficits that result from right hemisphere damage compared to aphasia (Kim et al, 2022).

Discourse Overview

Discourse can be simply defined as "language in use" (Pallickal and Hema, 2020). It is an important ability which reflects the functional communication used in everyday conversations and interactions. Successful discourse requires coordination of "linguistic, pragmatic, and behavioral skills" (Stubbs et al, 2018). For this reason, many adults with damage to the left or right hemisphere struggle with discourse production (Fergadiotis et al, 2019; Leaman & Edmonds, 2019). There are many genres of discourse production that are used in research to learn more about the language difficulties that certain populations face. These genres include picture descriptions, narrative, procedural, and conversational discourse (Stubbs et al, 2018). Narrative discourse, which includes story retelling; story generation; and personal event retelling, is the most common form of discourse analyzed in research (Stubbs et al, 2018).

Narrative discourse is a highly demanding and complex task that is needed in day-to-day life, that those with unilateral brain damage struggle with (Brisebois et al, 2022; Linnik et al 2016). Every year, more than 795,000 people in the United States have a stroke (CDC). With the incidence of having a stroke being so high, the chances of language impairment as a result of the unilateral brain damage that occurs are also high. "Among stroke survivors, 30–60% present with communication impairments (2,3). Aphasia is present in 15% (4) to 33% (2) of individuals with acute stroke" (Tippett, 2018). These communication impairments directly impact the quality of life of adults who suffer from strokes. Having impaired discourse abilities may lead to an unsatisfactory social and professional life (Linnik et al 2016). Those with impaired language abilities may suffer from limited social interaction, lower quality of life, and

isolation (Yu et al, 2017). Many clinical populations, including those with aphasia and RHD post stroke, struggle with discourse production and prioritize this linguistic skill in their recoveries (Fergadiotis et al, 2019; Leaman & Edmonds, 2019)

There are two levels used to commonly analyze different forms of discourse: the macrolinguistic level and the microlinguistic level (Karaduman et al, 2017). The microlinguistic level is concerned with assessing the intra-utterance level. This level focuses on the "lexical and grammatical processing that contribute[s] to intrasentential structure" and linguistic productivity (Karaduman et al, 2017; Stubbs et al, 2018). Measures such as total # of words, words per minute (WPM), and words per utterance can all be used to analyze linguistic productivity (Stubbs et al, 2018). The macrolinguistic level assesses the effectiveness of the discourse as a whole and "focuses on pragmatic and discourse-level processing, responsible for intersentential organization" (Karaduman et al, 2017). Coherence is a perceptual measure related to the overall quality and comprehensibility of the discourse produced (Bloom et al, 1996). Coherence, in addition to the actual content produced, can be used to assess the macrolinguistic level of the discourse produced (Stubbs et al, 2018). The amount, relevance, and correctness of the content produced in discourse plays an important role in the overall coherence (Nicholas and Brookshire, 1993; Nicholas and Brookshire, 1995; Brisebois et al, 2022).

In research, the macrolinguistic and microlinguistic levels of discourse are presumed to be represented differently between the two hemispheres, highlighting the roles each hemisphere has in language production. Discourse production analysis has been shown to display the language difficulties of many populations, including those with unilateral brain damage, by providing a means to 1) assess both the microlinguistic and

macrolinguistic levels of language production and 2) investigate the specific language impairments that different populations face in different discourse production modalities (Karaduman et al, 2017; Stubbs et al, 2018). Discourse production can help differentiate those with right hemisphere damage (RHD) and left hemisphere damage (aphasia), as it is commonly assumed in research that the left hemisphere is biased for microlinguistic processing and the right hemisphere is biased for macrolinguistic processing (Karaduman et al, 2017). Therefore, unilateral damage to the hemispheres should result in various and distinct language abilities that can be best seen and compared in discourse production.

However, due to the complex nature of discourse production, there is a great amount of overlap between the microlinguistic and macrolinguistic levels of production. A study comparing discourse of individuals with schizophrenia and neurologically normal individuals showed that the performance of an individual on the macrolinguistic level influences their performance on the microlinguistic level of discourse (Marini et al, 2008). The results indicated that "limited impairment found in microlinguistic abilities was influenced by macrolinguistic performance" (Marini et al, 2008). Further studies are finding that it is the performance on the microlinguistic level that affects performance on the macrolinguistic level (Leaman & Edmonds, 2019; Wright & Capilouto, 2012).

Discourse Production Analysis: Microlinguistics

Studies have shown, as largely expected, that those with aphasia have marked deficiencies in microlinguistic measures. For example, one study aimed to describe the discourse abilities of 15 adults with moderate aphasia and found that, overall, this population scored the lowest on the microlinguistic measures that were used to assess their discourse production (Ulatowska et al, 1983). In this study, participants were asked

to tell a personal story, construct a story from a sequence of pictures, and retell a story they were reading. The moderately aphasic group's discourse production, across the various discourse tasks, was "...reduced in both quantity and complexity and had errors, though primarily at the sentential level" (Ulatowska et al, 1983). In summary, their discourse production was shorter and included fewer complex sentences, displaying obvious deficits on the microlinguistic level. These results are congruent with those of other similar studies and the common perceptions of language difficulties arising from left hemisphere damage.

However, other studies have produced incompatible results. One study examined cohesion and coherence in unilaterally brain damaged adults (Bloom et al, 1996). These two measures are commonly used to assess the micro and macro linguistic levels of language production in research. Cohesion is a measure of microlinguistics that analyzes various lexical devices used to "...convey the relationship between different sentences or between different parts of sentences" (Bloom et al, 1996). Coherence is a measure of macrolinguistics that analyzes the general quality of the discourse as a whole and "...reflects a listener's ability to interpret the overall meaning of discourse" (Bloom et al, 1996). This study found those with aphasia produced more cohesive discourse compared to the RHD and control groups (Bloom et al, 1996). In other terms, the aphasic group showed the least deficits on the microlinguistic level of discourse production. This may indicate that those with aphasia can have preserved microlinguistic deficits, though it has not been commonly found.

Those with right-hemisphere damage are supposed to have preserved microlinguistic abilities. In the same study that found those with aphasia had no significant

microlinguistic deficits, it was also found that those with RHD also performed normally on measures of cohesion, suggesting that this group also did not have difficulties on the microlinguistic level (Bloom et al, 1996). Several studies have shown the opposite. For example, one study consisting of 22 participants with RHD and 12 with aphasia aimed to analyze the discourse production of adults with RHD. Participants watched a 9-minute video of a story and then retold the story and were scored on both coherence and cohesion (Uryase et al, 1991). This study found that those with RHD performed just as poorly as those with aphasia on cohesion. Similarly, the RHD group's discourse was "significantly less cohesive," containing "...a smaller number of complete and a greater number of incomplete cohesive markers" (Uryase et al, 1991). In general, the discourse production of the RHD group was shorter, less clear, and less connected on the intrersential level (Uryase et al, 1991). These findings may suggest that adults with RHD do, in fact, have difficulties with microlinguistics, similar to adults with aphasia, when compared to neurologically normal adults.

Discourse Production Analysis: Macrolinguistics

Some research has proven that those with RHD do have difficulties with language and discourse production on the macrolinguistic level as widely believed. One study had participants with RHD and neurologically normal controls produce narrative discourse (Bartels-Tobin & Hinckley, 2005). Use and frequency of main concepts were used to assess the macrolinguistic capabilities of these two groups (Bartels-Tobin & Hinckley, 2005). Those with RHD used a deficient number of main concepts in their discourse, solidifying the theory that those with RHD perform lower on measures of macrolinguistics (Bartels-Tobin & Hinckley, 2005). This means that, overall, this group

included significantly less content that was essential to retelling the story completely. Despite these understandable findings, some research has inferred that those with RHD may perform similarly to neurologically normal adults in terms of macrolinguistics, having minimal content and narrative episodes missing from their discourse production (Bloom et al, 1996). Therefore, the RHD group's "...performance on structured discourse tasks did not support anecdotal and clinical observations regarding copious and incoherent language" (Bloom et al, 1996). Findings such as these may indicate that RHD does not consistently result in language difficulties on the macrolinguistic level as often assumed.

Individuals with aphasia have underperformed in measures of macrolinguistics, though it is assumed that these abilities should be maintained. A previously cited study compared the discourse production of individuals with RHD, aphasia, and no unilateral brain damage and aimed to analyze both the macro and micro linguistic levels of discourse using coherence and cohesion (Bloom et al 1996). These results indicated that those with aphasia performed the lowest on measures of macrolinguistics and had the least coherent stories compared to the other groups (Boom et al 1996). Other, more recent, studies have backed these findings and found that, "...LHD people's narratives were less complex as indicated by fewer story components included in their narratives compared to control participants" (Karaduman et al, 2017). This shows that those with aphasia have tended to show deficits in macrolinguistic abilities compared to other clinical populations, including those with RHD. With numerous studies supporting findings such as these, it is important to consider the presumptions made about macrolinguistic abilities of adults with aphasia, in particular.

Possible Causes of Conflicting Findings

There are many possible reasons for the conflicting findings and the various outcomes of so many studies in this area of research. First, education level has proven to be a crucial factor in many studies that assessed discourse production. Education level may determine the quality of the discourse produced by participants. For this reason, results in which participants in the study had a low education level should be taken with caution. For example, the study which found that adults with aphasia performed worse on measures of coherence and macrolinguistics compared to the right-hemisphere damaged group and the neurologically normal group (Karaduman et al, 2017). However, the aphasic group used in this study had a significantly low education level (mean=13.56 years), especially compared to the normal control group (mean= 16 years) (Karaduman et al, 2017). This could explain the deficits that were noted in the aphasic group's discourse production on the macrolinguistic level.

Secondly, because they struggle primarily with macrolinguistic and pragmatic abilities including producing overly- long, less efficient, unorganized, insignificant, and off topic utterances, many researchers conclude that adults with RHD language difficulties result from cognitive deficits (Minga et al, 2021). Cognition obviously impacts language production, especially on the discourse level. However, it may not contribute to the macrolinguistic difficulties that people with RHD have as much as it has been thought to. Studies that have analyzed the discourse of adults with RHD have also assessed their cognition. One study used the Cognitive Linguistic Quick Test (CLQT) to compare the cognitive abilities of the RHD group used in the study and the normal control group. This study found that the scores between the groups did not differ

significantly, indicating that the RHD group has similar cognitive abilities as the control group (Bartels-Tobin & Hinckley 472). Therefore, language difficulties, particularly on the macrolinguistic level, that result from RHD may not be as rooted in cognitive deficits as previously thought. (How can this impact results).

The type of stimulus used to elicit discourse production can also impact the results of research that aims to analyze discourse production. Those with unilateral brain damage may respond differently to different types of stimuli, depending on which hemisphere their injury occurred. This hypothesis was tested by one study, whose participants were asked to produce discourse under three different conditions and stimuli. They were asked to first read stories and then to retell those stories aloud. Then, participants produced stories based on a sequence of pictures. Lastly, they were asked to arrange a series of pictures into a plausible sequence that portrayed a story (Marini et al, 2005). Overall, this study found that the performance of the RHD and aphasic groups varied depending on the condition used to elicit discourse production (Marini et al, 2005). This suggests that results of other studies that use stimuli that this study has proven to provide varying results, may be skewed based on this variable.

Correct Information Unit (CIU)

As can be seen in the previous studies (Karaduman et al, 2017; Boom et al 1996; Bartels-Tobin & Hinckley, 2005; Uryase et al, 1991; Ulatowska et al, 1983), measures, such as coherence; cohesion items including anaphora, deictic terms, indefinite terms, connective devices, and definite articles; main concepts; T-units; embedding; words per minute (WPM); narrative episodes; and story grammar are not always reliable and consistent measures, especially when comparing language abilities of adults with

unilateral brain damage (Brisebois et al, 2022). Similarly, there is a lack of uniform methods of analysis when it comes to discourse. Armstrong, in her review, states that the incompatible findings related to discourse production in various clinical populations may be a result of the various methodologies used currently (2000). It is important that other potential methods of comparison are further researched so that they can be used more uniformly in discourse analysis.

Correct Information Units (CIUs) were originally developed by Nicholas and Brookshire aiming to discriminate aphasic from non-aphasic speech more reliably (1993). CIUs "words that are intelligible in context, accurate in relation to the picture(s) or topic, and relevant to and informative about the content of the picture(s) or the topic" (Nicholas & Brookshire, 1993, p. 348). CIUs reflect the effectiveness and informativeness of discourse production (Nicholas & Brookshire, 1993). This discourse analysis system has been shown to discriminate successfully and consistently between the discourse of aphasics and non-aphasics, adults with RHD and non-brain damaged adults, adults with TBI and non-brain damaged adults, as well as older and younger adults (Nicholas & Brookshire, 1993; Nicholas & Brookshire, 1995; Bartels-Tobin and Hinckley, 2005; Capilouto et al, 2005; Stubbs et al, 2018).

Though CIUs were originally created to be linguistic measures that assess the word-level, or microstructure of discourse (Leaman & Edmonds, 2019), measures of CIUs are also seen to analyze both the microstructure and microstructure. Content Units (CUs), which were foundational in the creation of CIUs, are suggested to be a measure that assesses both the macrostructure and the microstructure of discourse (Brisebois et al, 2022). One measure assessed using CIUs is the informativeness of the content produced.

Informativeness is an important skill needed for effective discourse and can lead to greater success in discourse abilities (Brisebois et al, 2022; Leaman & Edmonds, 2019). Additionally, CIUs assess relevance and correctness (Nicholas and Brookshire, 1993; Nicholas and Brookshire, 1995). Informativeness, relevancy, and correctness can all be presumed to affect the macrostructure of discourse, as they relate to overall coherence (Stubbs et al, 2018; Nicholas and Brookshire, 1993; Nicholas and Brookshire, 1995; Brisebois et al, 2022). It can also be assumed that #CIUs and #CIUs/Min, like WPM, measure linguistic productivity which impacts discourse on the microlinguistic level (Stubbs et al, 2018).

Capable of measuring macrolinguistic measures such as informativeness, relevance, and correctness of discourse, in addition microlinguistic measures, such as linguistic productivity, it can be assumed that CIUs may serve as a useful tool to assess discourse production in greater depth, compared to other measures (Brisebois et al, 2022, Leaman & Edmonds, 2019). Analyzing total # of CIUs, CIUs/Minute, and percent CIUs (%CIU) together provides a more comprehensive understanding of an individual's language impairment (Nicholas &Brookshire 1993; Bryant, Ferguson, & Spencer, 2016).

Additionally, CIUs are determined using a highly specific and descriptive set of rules set by Nicholas and Brookshire (1993), which may lead to less ambiguity and disagreements among researchers rating and evaluating discourse production. One study suggests poor interrater reliability (IRR) in CIU measures due to lack of rater training (Oelschlaeger & Thorne, 1999; Leaman & Edmonds, 2019). However, most studies examining the reliability of CIU measures, have found that these measures have particularly high IRR (Leaman & Edmonds, 2019). The increased amount of information

these measures provide, in addition to high IRR, make CIUs a much needed and meaningful discourse analysis measure (Leaman & Edmonds, 2019; Kurland & Stokes, 2018).

Current studies have shown that measures of Correct Information Units (CIUs) are consistent and reliable in distinguishing between adults with unilateral brain damage and neurologically normal adults (Nicholas & Brookshire, 1993). Adults with aphasia following left hemisphere damage performed significantly lower on both measures of CIUs/minute and percentage CIUs (% CIUs) compared to the non-brain damaged control group (Nicholas & Brookshire, 1993). CIUs/minute and % CIUs were shown to be stable across sessions in a research study that analyzed discourse production in adults with aphasia (Nicholas & Brookshire, 1993). %CIUs was the most unchanging measure across sessions, suggesting that this measure may be a reliable way to analyze aphasic speech and track changes in discourse performance in these individuals (Nicholas & Brookshire, 1993). More recent studies, however, have found that #CIUs, not %CIUs, are more reliable (though both measures are still assumed to be reliable in comparison to other measures) (Leaman & Edmonds, 2019).

A similar study found that, as with discourse production in adults with aphasia, narrative discourse production in adults with RHD can be distinguished from discourse produced by neurologically normal controls using measures of CIUs (Bartels-Tobin and Hinckley, 2005). Similarly to adults with aphasia in previous studies, those with RHD produced significantly less CIUs total, %CIUs, and CIUs/minute compared to the control group in their discourse production (Bartels-Tobin and Hinckley, 2005). These findings make sense given that those with RHD struggle with the cognitive aspect of language,

affecting topic maintenance, organization, and relevance of discourse (Minga et al, 2018). As previously mentioned, CIUs are "words that are intelligible in context, accurate in relation to the picture(s) or topic, and relevant to and informative about the content of the picture(s) or the topic" (Nicholas & Brookshire, 1993, p. 348). Therefore, one could assume that adults with RHD would perform lower on these measures, given that they analyze macrostructural elements of discourse such as relevancy and topic maintenance. This suggests that these measures of CIUs can be reliably used not just to discriminate aphasic speech from non-aphasic speech. CIUs can also discriminate the discourse produced by those with RHD from neurologically normal groups, highlighting the cognitive language deficits that individuals with RHD experience.

The information on the macrostructure and microstructure that CIU measures provide, their high interrater reliability, ability to distinguish the discourse produced by different populations, and stability across sessions, make CIUs a promising tool to analyze discourse more accurately and reliably than other discourse analysis measures, especially when comparing individuals with unilateral brain damage (Nicholas & Brookshire, 1993; Nicholas & Brookshire, 1995; Bartels-Tobin and Hinckley, 2005; Capilouto et al, 2005; Stubbs et al, 2018).Since CIUs were initially used to distinguish aphasic speech more reliably from non-aphasic speech, most research has focused on using CIUs to analyze aphasic discourse, rather than discourse produced by individuals with RHD (Nicholas and Brookshire, 1993). As a result, there has been little research done to compare the differences in measures of CIUs in adults with aphasia and adults with RHD to better understand narrative discourse production differences between these groups. Both groups have shown to have language impairments, demonstrated by their

statistically significantly lower performance on measures of CIUs when compared to normal controls in separate studies (Bartels-Tobin and Hinckley, 2005; Nicholas & Brookshire, 1993; Nicholas & Brookshire, 1995). Further research is needed to compare the narrative discourse production between individuals with aphasia and individuals with RHD using CIUs to gain better insight on the language abilities of these two populations.

CHAPTER TWO

Aims and Methods

Aims

The aim of this study is to compare the discourse production differences in individuals with RHD and individuals with aphasia, using measures of CIUs to gain more insight on the specific language difficulties of these two populations, on both the macrolinguistic and microlinguistic levels of discourse. Though other studies have examined measures of CIUs in these populations, these studies did not directly compare them to one another. This study will compare measures of CIUs between these two clinical populations to determine if individuals with aphasia and individuals with RHD have statistically significant differences in narrative discourse production. We hypothesize that there will be statistically significant differences in measures of CIUs between individuals with RHD and individuals with aphasia. Additionally, both groups performed lower on all measures of CIUs in previous studies when compared to non-brain damaged individuals (Nicholas and Brookshire, 1993; Nicholas and Brookshire, 1995; Bartels-Tobin and Hinckley, 2005). However, individuals with aphasia have more obvious and severe language deficits when compared to individuals with RHD, whose language deficits are cognitively based and less prominent (Karaduman et al, 2018; Minga et al, 2021). Keeping this idea in mind and the fact that CIUs were developed as a linguistic measure used to primarily assess the word-level of discourse production, we further hypothesize that individuals with aphasia will perform lower on all measures of CIUs analyzed.

Participants

Transcripts of 15 individuals with RHD and 15 individuals with aphasia were randomly selected from the TalkBank DataBase to compare the discourse production differences between the two populations using the Cinderella story retell task. To fit inclusion criteria, individuals in the aphasic group had to be classified as aphasic; individuals whose aphasia type listed in the demographic information table in AphasiaBank as non-aphasic or unknown were excluded. Individuals with aphasia and RHD needed the duration time of their Cinderella story retelling to exceed forty-five seconds for inclusion, to ensure sufficient discourse was produced for analysis. The 45 second cut off used comes from a study from 2010 which found that spoken language samples of roughly a minute produced just as stable measures compared to language samples that were 3 and 7 minutes in length (Heilmann, Nockerts, & Miller, 2010). Individuals were grouped according to their lesion site. Group 1 consisted of 15 individuals with aphasia, resulting from left-hemisphere damage. Aphasic individuals diagnosed aphasia types included Broca's (n=3), Transmotor (n=1), Conduction (n=3), Wernicke's (n=3), and Anomic (n=5). Group 2 consisted of 14 individuals with RHD.

Individuals were matched for age, sex, post onset time (POT), and education. Group 1 had a mean age of 57.00 years (SD=11.88), and mean years of education was 16.47 years (SD=3.62). Additionally, Group 1 had a mean Western Aphasia Battery Aphasia Quotient (WAB-AQ) of 74.4 and their mean POT was 5.73 years (See Table 1 for Group 1 demographic information). Group 2 had a mean age of 54.32 years (SD=12.93), and mean years of education was 18.20 years (SD=4.62). Group 2 had no

WAB-AQ scores available. The POT for Group 2 was 4.20 years (See Table 2 for Group 2 demographic information).

Table 1.
Demographic Information for Individuals with Aphasia

Participant	Aphasia type	Language	Sex	Race	POT (yrs)	WAB-AQ	Education	Age
1	Broca	eng	1	WH	11.80	63.9	18	69.92
2	Transmotor	eng	1	WH	3.3	74.6	14	53.08
3	Broca	eng	1	AA	1.0	40.5	12	39.42
4	Conduction	eng	1	WH	7.9	80.1	13	56.17
5	Wernicke	eng	2	AA	9.8	57.4	12	48.33
6	Wernicke	eng	2	WH	2.2	48.9	16	61.67
7	Conduction	eng	1	WH	7.8	79.5	12	83
8	Anomic	eng	2	WH	1.25	86.8	13	58.92
9	Conduction	eng	2	WH	5.25	74.9	20	69.75
10	Anomic	eng	2	WH	2.20	78.5	21	56.75
11	Anomic	eng	1	WH	5.70	89.6	18	35.42
12	Anomic	eng	2	WH	8.25	70.6	22	57.42
13	Broca	eng	2	AS	11.0	66.2	20	55.17
14	Anomic	eng	2	WH	5.0	85.7	16	48.17
15	Wernicke	eng	2	WH	3.50	74.4	20	57.33
					Mean= 5.73	Mean= 72.11	Mean= 16.47	Mean= 57.0
					SD= 3.54	SD= 15.10	SD= 3.62	SD= 11.88

Eng: English; Gender: 1-female, 2- male; Race: WH- white, AA- African American, OTH- other

Table 2.
Demographic Information of Individuals with RHD

Participant	Language	Sex	Race	POT (yrs)	WAB-AQ	Education	Age
16	eng	1	WH	7.1	-	18	68.50
17	eng	2	WH	3.1	-	15	56
18	eng	1	AA	13	-	21	64.17
19	eng	1	AA	5.5	-	18	53.67
20	eng	2	OTH	3.5	-	16	73.67
21	eng	2	WH	2.2	-	20	55.33
22	eng	2	WH	2.17	-	14	31.08
23	eng	2	WH	2.5	-	13	57.83
24	eng	1	WH	7	-	18	48.08
25	eng	2	WH	0.83	-	18	72.67
26	eng	1	WH	0.2	-	26	38
27	eng	2	WH	0.92	-	16	58
28	eng	1	AA	4.6	-	16	42.33
29	eng	2	WH	4.33	-	14	58.42
30	eng	1	AA	6.1	-	30	37.08
				Mean= 4.20	Mean -	Mean= 18.20	Mean= 54.32
				SD= 3.27	SD -	SD= 4.62	SD= 12.93

Eng: English; Gender: 1-female, 2- male; Race: WH- white, AA- African American, OTH- other

Methods

Transcripts for each individual used in this study were collected according to the AphasiaBank and RHDBank protocol. For more information on data collection protocol, data storage and distribution rules and IRB guidelines, visit https://www.talkbank.org/. Transcripts are composed of multiple cognitive and language tasks directed by a clinician/researcher and performed by the individual. For this study's purposes, only the Cinderella Story retell task was used to analyze discourse production. In a 2016 literature

review, narrative retellings were the most common form of discourse elicitation genre, and 29 of the studies reviewed used the retelling of the wordless Cinderella Story (Bryant, Ferguson, & Spencer, 2016). For this task, each individual was prompted to flip through a wordless depiction of the Cinderella story and then were asked to retell the story, according to the guidelines set by TalkBank. Transcripts of the Cinderella Story were collected for each individual, in the CHAT format, and then analyzed further using Computerized Language Analysis Software (CLAN). Transcripts were run through this program using the EVAL function, which analyzes the individuals' discourse performance (https://talkbank.org/manuals/CLAN.pdf). Measures such as total # words, words per minute (WPM), verbs per utterance, and mean length of utterance (MLU) automatically calculated for each individual and used as additional measures of analysis, in addition to CIU measures to provide additional information. After running the EVAL command in CLAN, transcripts were downloaded and used for further analysis of CIUs.

CIU Analysis

Correct Information Units (CIUs) are words that are accurate, relevant, and informative. CIUs reflect the effectiveness and informativeness of discourse production (Nicholas & Brookshire, 1993). Measures of CIUs can provide more accurate and consistent information on the discourse production difficulties in different populations, such as those with unilateral brain damage (Bartels-Tobin & Hinckley, 2005; Nicholas & Brookshire, 1993; Nicholas and Brookshire, 1995). From the Cinderella Story retell transcripts, the narrative discourse of individuals with RHD and individuals with aphasia, was further analyzed for CIUs using the guidelines outlined by Nicholas and Brookshire (1993; 1995). Words that count as a CIU must first be included in the total word count.

To be counted as a word, a word must be intelligible, but not accurate, relevant, or informative (Nicholas and Brookshire, 1993). Filler words and words unintelligible in context should not be counted as a CIU (Nicholas and Brookshire, 1993). Examples of words that would not be included in the total word count or considered as a CIU include: um, er, uh, and jargon words such as norble, frampi, etc. (Nicholas and Brookshire, 1993).

After all words not to be counted towards the word count were excluded, the remaining words in each transcript were analyzed for CIUs. For a word to be counted as a CIU, a word must be intelligible, accurate, relevant, and informative in relation to the context of the story (Nicholas and Brookshire, 1993). Words do not have to be grammatically correct to be counted as a CIU, however (Nicholas and Brookshire, 1993). Further, each CIU is one word only (Nicholas and Brookshire, 1993). Incorrect words should not be counted as CIUs (Nicholas and Brookshire, 1993). For example, if a participant were to say "The boy is eating ice cream" but the picture showed a girl eating ice cream, boy would not be counted as a CIU. Repetitions of words that add no additional meaning, ambiguous or non-specific words, filler phrases, the conjunction "and," commentary on the task, and commentary on performance should not be counted as CIUs. For more information on word and CIU counting rules, see Appendix A (Nicholas and Brookshire, 1993).

CIUs were counted using the rules outlined above. Afterwards, all words that were not to be counted as CIUs were coded with [e] so that CLAN would not count these words towards the measures of CIUs calculated (https://aphasia.talkbank.org/discourse/). If multiple words in a row were to be excluded as CIUs they were placed in angle

brackets (< >) (https://aphasia.talkbank.org/discourse/). After all non CIU words were coded for exclusion, the following commands were run:

1. freq +t*par *.cha -s"<e>" to calculate all CIU words (those not marked with [e])
    a. freq +t*par *.cha +s"<e>" to calculate all non-CIU words (those marked with [e])
    b. timedur +t*par +r6 +d1 *.cha to calculate all words per minute
    c. timedur +t*par +d1 -s"<e>" *.cha to calculate all CIU words per minute.

After the results of these commands were obtained, % CIUs were manually calculated by dividing the total # CIU words found by the first command by the total # of words found by running the EVAL command in CLAN.

Data Analysis

Data collected for each individual was further analyzed to determine the effectiveness of using Nicholas and Brookshire's CIU as a tool to analyze and discriminate between the discourse production of individuals with aphasia and RHD, on both the microlinguistic and macrolinguistic levels. IBM's Statistical Package for the Social Sciences (SPSS) version 28.0.1.1 was used for statistical analysis of total number of CIUs (#CIUs), number of CIU words per minute (#CIUs/Min), and percentage CIU (%CIU), as well as additionally measure such as verbs per utterance, MLU, WPM, and total # words. A Kruskal-Wallis H test and a Mann-Whitney U test were performed to determine if there were any significant differences in CIU, CIUs/minute, and %CIU between the two groups.

CHAPTER THREE

Results

An Independent Samples T-Test was first conducted to check for statistically significant differences in age, education, and post onset time (POT) between Group 1 (individuals with aphasia) and Group 2 (individuals with RHD). This test found that no statistically significant differences existed between the groups age $t(28) = -1.144$, $p = .131$; education $t(28) = .524$, $p = .302$; or POT $t(28) = 1.226$, $p = .115$. The 95% confidence intervals between the means for the sample ranged from [-4.837 to 1.370] for education, [-6.912 to 11.668] for age, and [-1.024 to 4.077] for POT. The results of this test indicate that none of these variables affected the study's overall findings.

Shapiro-Wilk test of normality was conducted to determine whether the data for #CIUs, #CIUs/Min, and %CIUs were normally distributed. The results indicate that we must reject the null hypothesis for %CIUs data (p= 0.006) and conclude that the data is not normally distributed. The results also indicated that we fail to reject the null hypothesis for #CIUs (p=.061) and #CIUs/Min (p= 0.111) and conclude that the data for these two measures were normally distributed. Additionally, Boxplots generated by the Shapiro-Wilk test of normality revealed that individuals 3 and 9 fell outside the normal value range compared to the rest of the dataset, especially in %CIUs, falling within four and three standard deviations from the mean (0.68), respectively. Because not all three measures of CIUs were normally distributed, the data for all three measures was transformed using a log10 transformation. Additionally, due to the abnormal values found for individuals 3 and 9, the dataset was trimmed and the values for %CIUs, #CIUs,

and #CIUs/Min for both individuals were replaced with the means of the rest of the dataset for these measures. The mean value for the rest of the dataset used for replacement was 0.68 for %CIUs, 241.5 for #CIUs, and 76.20 for #CIUs/Min.

After data trimming and log10 transformation a second Shapiro-Wilk test for normality was conducted to determine whether the log10 transformed data for each of the three CIU measures was normally distributed. The results indicate that we must reject the null hypothesis for #CIUs/Min data (p= 0.002) and conclude that the data is not normally distributed. The results also indicated that we fail to reject the null hypothesis for #CIUs (p=.476) and %CIUs (p= 0.066) and conclude that the data for these two measures was normally distributed.

Further, the Shapiro-Wilk test of normality was used to determine whether the trimmed and log10 transformed data for total # words, MLU, WPM, and verbs per utterance were normally distributed. The results indicated that we must reject the null hypothesis for total # words (*p=0.33*) and conclude that the data is not normally distributed. The results also indicated that we fail to reject the null hypothesis for MLU (*p= 0.832*), WPM (*p= 0.198*), and verbs per utterance (*p= 0.84*), concluding that the data for these additional measures were normally distributed. Because the log10 transformed data was still not normally distributed for all measures, nonparametric testing was used to analyze the dataset.

An analysis of the discourse of 15 individuals with RHD and 15 individuals with aphasia found that 1) there were significant group differences in #CIUs, #CIUs/Min, and %CIUs and 2) those with RHD performed significantly better on #CIUs, CIUs/minute, and %CIUs. Additionally, significant differences between groups were found for other

measures such as MLU, WPM, and verbs per utterance, with individuals with RHD outperforming those with aphasia on all measures. A Kruskal-Wallis H test was performed, using the trimmed log10 transformed data, to determine if there were any significant differences in these measures between the two groups of individuals. Table 1 displays the descriptive statistics of the trimmed raw #CIUs, #CIUs/Min, %CIUs, total # words, MLU, WPM, and verbs per utterance data. See Table 2 for the descriptive statistics of the trimmed Log10 transformed data.

Table 3.
Mean and Standard Deviation of trimmed raw data for #CIUs, #CIUs/Min, and %CIUs, total # words, WPM, MLU, and verbs/utterance

Variables	Group	N	Mean	Std. Deviation
#CIU	Aphasia	15	156.13	83.99
	RHD	15	335.53	139.51
#CIU/Min	Aphasia	15	48.46	23.77
	RHD	15	105.75	26.99
%CIU	Aphasia	15	0.59	0.12
	RHD	15	0.78	0.06
Total # words	Aphasia	15	266.33	210.84
	RHD	15	432.13	181.57
WPM	Aphasia	15	74.39	29.46
	RHD	15	134.65	29.72
MLU	Aphasia	15	5.88	1.84
	RHD	15	8.66	1.37
Verbs/utterance	Aphasia	15	0.88	0.51
	RHD	15	1.60	0.27

Log10CIU= Total # of CIUs; Log10CIUmin= #CIUs per Minute; Log10CIUper= %CIUs; Log10words= Total # of Words; Log10WPM= Words per Minute; Log10MLU= Mean Length of Utterance;
Log10VperU= Verbs per Utterance

Table 4.
Mean and Standard Deviation of trimmed Log10 transformed data for #CIUs, #CIUs/Min, and %CIUs, total # words, WPM, MLU, and verbs/utterance.

Variables	Group	N	Mean	Std. Deviation
Log10CIU	Aphasia	15	2.13	0.25
	RHD	15	2.49	0.20
Log10CIUmin	Aphasia	15	1.64	0.22
	RHD	15	2.01	0.13
Log10CIUper	Aphasia	15	-0.24	0.09
	RHD	15	-0.11	0.04
Log10words	Aphasia	15	2.32	0.32
	RHD	15	2.56	0.20
Log10WPM	Aphasia	15	1.84	0.18
	RHD	15	2.12	0.10
Log10MLU	Aphasia	15	0.75	0.15
	RHD	15	0.93	0.07
Log10VperU	Aphasia	14	-0.12	0.36
	RHD	15	0.20	0.07

Log10CIU= Total # of CIUs; Log10CIUmin= #CIUs per Minute; Log10CIUper= %CIUs; Log10words= Total # of Words; Log10WPM= Words per Minute; Log10MLU= Mean Length of Utterance;
Log10VperU= Verbs per Utterance

A Kruskal-Wallis H test showed that there was a statistically significant difference in #CIUs, $\chi^2(1) = 12.287$, $p = <0.001$, with a mean rank #CIUs of 9.87 for the

aphasic group and 21.13 for the RHD group; #CIUs/Min, $\chi^2(1) = 17.728$, p = <0.001, with a mean rank #CIUs/Min of 8.73 for the aphasic group and 22.27 for the RHD group; and %CIUs, $\chi^2(1) = 17.381$, p = <0.001, with a mean rank %CIUs of 8.80 for the aphasic group and 22.20 for the RHD group. The test results reveal that there were statistically significant differences between the discourse production of individuals with aphasia and individuals with RHD on all three CIU measures analyzed.

Additionally, the Kruskal-Wallis H test produced statistically significant differences between groups, in the non-CIU measures analyzed such as total # words, $\chi^2(1) = 7.808$, $p = 0.006$, with a mean rank total # words of 11.07 for the aphasic group and 19.03 for the RHD group; WPM, $\chi^2(1) = 14.720$, $p = <0.001$, with a mean rank WPM of 9.33 for the aphasic group and 21.67 for the RHD group; MLU, $\chi^2(1) = 13.475$, $p = <0.001$, with a mean rank MLU of 9.60 for the aphasic group and 21.40 for the RHD group; and verbs per utterance, $\chi^2(1) = 12.808$, $p = <0.001$, with a mean rank verbs per utterance of 9.14 for the aphasic group and 20.47 for the RHD group.

See Table 3 for the Kruskal Wallis H test ranks for #CIUs (labeled Log10CIU), #CIUs/Min (labeled Log10CIUmin), %CIUs (labeled Log10CIUper), total # words (labeled Log10words), WPM (labeled Log10WPM), MLU (labeled Log10MLU), and verbs per utterance (labeled Log10VperU). See Table 4 for the Kruskal Wallis H test statistics for #CIUs (labeled Log10CIU), #CIUs/Min (labeled Log10CIUmin), %CIUs (labeled Log10CIUper), total # words (labeled Log10words), WPM (labeled

Log10WPM), MLU (labeled Log10MLU), and verbs per utterance (labeled Log10VperU).

Table 5.
Kruskal Wallis H test results for trimmed Log10 #CIUs, #CIUs/Min, and %CIUs, total # words, WPM, MLU, and verbs per utterance data.

Variable	Group	N	Mean Rank
Log10CIU	Aphasia	15	9.87
	RHD	15	21.13
Log10CIUmin	Aphasia	15	8.73
	RHD	15	22.27
Log10CIUper	Aphasia	15	8.80
	RHD	15	22.20
Log10words	Aphasia	15	11.07
	RHD	15	19.93
Log10WPM	Aphasia	15	9.33
	RHD	15	21.67
Log10MLU	Aphasia	15	9.60
	RHD	15	21.40
Log10VperU	Aphasia	14	9.14
	RHD	15	20.47

Log10CIU= Total # of CIUs; Log10CIUmin= #CIUs per Minute; Log10CIUper= %CIUs; Log10words= Total # of Words; Log10WPM= Words per Minute; Log10MLU= Mean Length of Utterance;
Log10VperU= Verbs per Utterance

Table 6.
Kruskal Wallis H test results for Log10 #CIUs, #CIUs/Min, and %CIUs, total # words, WPM, MLU, and verbs per utterance data.

	Log10 CIU	Log10 CIUmin	Log10 CIUper	Log10 words	Log10 WPM	Log10 MLU	Log10 VperU
Kruskal-Wallis H	12.29	17.73	17.38	7.61	14.72	13.48	12.81
df	1	1	1	1	1	1	1
Asymp. Sig.	<.001	<.001	<.001	.006	<.001	<.001	<.001

Log10CIU= Total # of CIUs; Log10CIUmin= #CIUs per Minute; Log10CIUper= %CIUs; Log10words= Total # of Words; Log10WPM= Words per Minute; Log10MLU= Mean Length of Utterance;
Log10VperU= Verbs per Utterance

Additionally, A Mann-Whitney U test was performed, using the trimmed Log10 transformed data, to further evaluate how #CIUs, #CIUs/Min, %CIUs, as well as the non-CIU discourse analysis measures, differed between the aphasic and the RHD groups. The results indicated that the RHD group had significantly higher #CIUs (U = 28.00, $p = < 0.001$), #CIUs/Min (U =11.00, $p =< 0.001$), and %CIUs (U =12.00, $p = < 0.001$) in their discourse samples when compared to the aphasic group. Similarly, the RHD group also had significantly higher total # words (U= 46.00, $p=0.006$), WPM (U=20.00, $p=<0.001$), MLU (U=24.00, $p=<0.001$), and verbs per utterance (U=23.00, $p=<0.001$).

Table 5 displays the ranks of the Mann-Whitney U test for #CIUs (labeled Log10CIU), #CIUs/Min (labeled Log10CIUmin), %CIUs (labeled Log10CIUper), total #

words (labeled Log10words), WPM (labeled Log10WPM), MLU (labeled Log10MLU), and verbs per utterance (labeled Log10VperU). Table 6 displays the test statistics of the Mann-Whitney U test for #CIUs (labeled Log10CIU), #CIUs/Min (labeled Log10CIUmin), %CIUs (labeled Log10CIUper), total # words (labeled Log10words), WPM (labeled Log10WPM), MLU (labeled Log10MLU), and verbs per utterance (labeled Log10VperU). Figures 1 and 2 display cluster bar charts which show the means for each group for each measure analyzed to further explain intergroup differences.

Table 7.
Mann-Whitney U test results for Log10 #CIUs, #CIUs/Min, and %CIUs #CIUs, total # words, WPM, MLU, and verbs per utterance data.

Variables	Group	N	Mean Rank	Sum of Ranks
Log10CIU	Aphasia	15	9.87	148.00
	RHD	15	21.13	317.00
Log10CIUmin	Aphasia	15	8.73	131.00
	RHD	15	22.27	334.00
Log10CIUper	Aphasia	15	8.80	132.00
	RHD	15	22.20	333.00
Log10words	Aphasia	15	11.07	166.00
	RHD	15	19.93	299.00
Log10WPM	Aphasia	15	9.33	140.00
	RHD	15	21.67	325.00
Log10MLU	Aphasia	15	9.60	144.00
	RHD	15	21.40	321.00
	Aphasia	15	9.14	128.00

Log10VperU				
	RHD	15	20.47	307.00

Log10CIU= Total # of CIUs; Log10CIUmin= #CIUs per Minute; Log10CIUper= %CIUs; Log10words= Total # of Words; Log10WPM= Words per Minute; Log10MLU= Mean Length of Utterance;
Log10VperU= Verbs per Utterance

Table 8.
Mann-Whitney U test results for Log10 #CIUs, #CIUs/Min, and %CIUs #CIUs, total # words, WPM, MLU, and verbs per utterance data.

	Log10 CIU	Log10 CIUmin	Log10 CIUper	Log10 words	Log10 WPM	Log10 MLU	Log10 VperU
Mann-Whitney U	28.00	11.00	12.00	46.00	20.00	24.00	23.00
Wilcoxon W	148.00	131.00	132.00	166.00	140.00	144.00	128.00
Z	-3.51	-4.21	-4.169	-2.76	-3.84	-3.67	-3.58
Asymp. Sig. (2-tailed)	<.001	<.001	<.001	.006	<.001	<.001	<.001
Exact Sig. [2*(1-tailed Sig.)]	<.001[b]	<.001[b]	<.001[b]	.005	<.001	<.001	<.001

Log10CIU= Total # of CIUs; Log10CIUmin= #CIUs per Minute; Log10CIUper= %CIUs; Log10words= Total # of Words; Log10WPM= Words per Minute; Log10MLU= Mean Length of Utterance;
Log10VperU= Verbs per Utterance

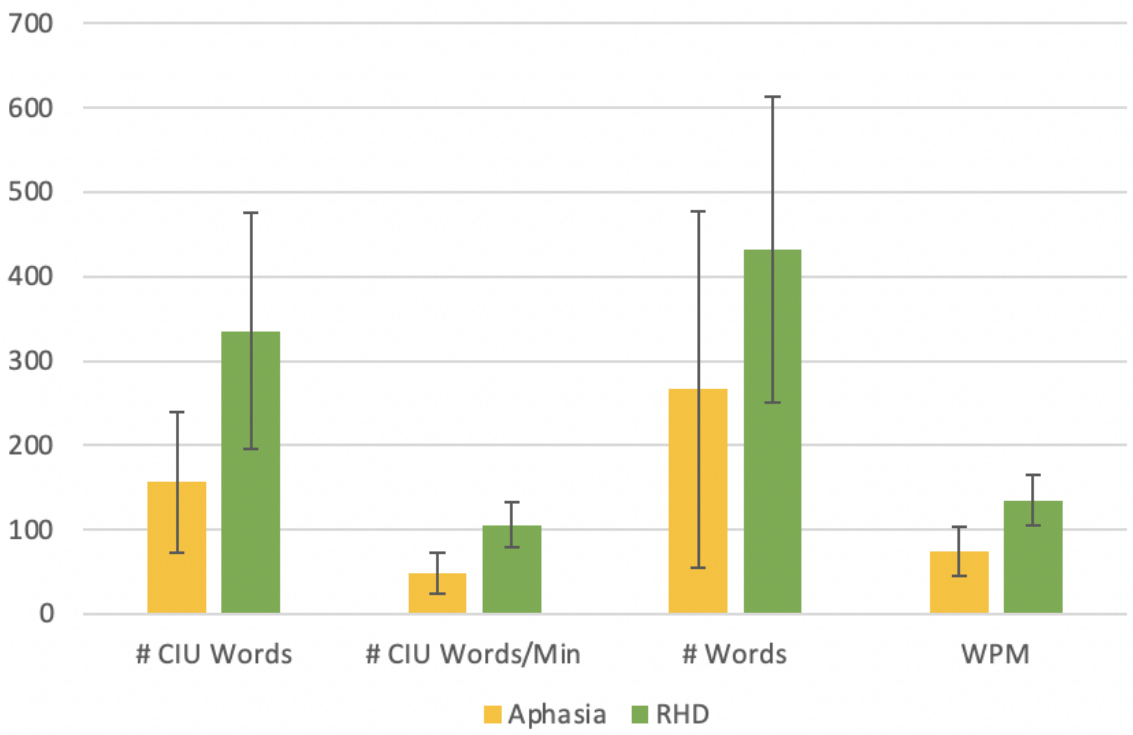

Figure 1. Cluster bar chart displaying mean #CIU, #CIU/Min, total # words, and WPM in individuals with Aphasia vs individuals with RHD. The means for each measure are shown in yellow for individuals with Aphasia and green for individuals with green.

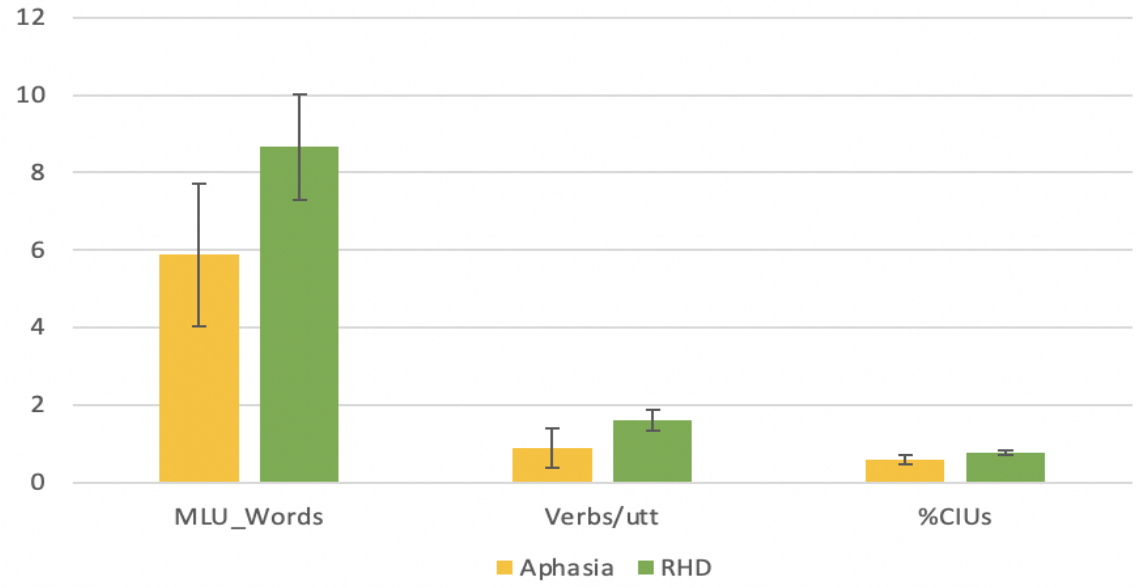

Figure 2. Cluster bar chart displaying the mean %CIU, Verbs per Utterance, and MLU in individuals with Aphasia and individuals with RHD. The means for each measure are shown in yellow for individuals with Aphasia and green for individuals with green.

CHAPTER FOUR

Discussion

The current study investigated narrative discourse production between individuals with RHD and individuals with aphasia, using CIUs and other discourse production measures, such as WPM, MLU, total # of words, and verbs per utterance to gain a deeper understanding of the language difficulties of each group on both the microlinguistic and macrolinguistic level. A comparison of narrative discourse between these two populations has not been done using CIUs. This study utilized CIUs to determine if individuals with aphasia and individuals with RHD have statistically significant differences in narrative discourse production using these measures. We hypothesized that 1) there will be statistically significant differences in measures of CIUs between individuals with RHD and individuals with aphasia and 2) individuals with aphasia will perform lower than the individuals with RHD on all measures of CIUs analyzed.

We made this hypothesis for three reasons. 1) Previous studies have found that aphasic individuals performed lower on measures of CIUs in previous studies, when compared to neurologically normal controls (Nicholas & Brookshire, 1993). The results of Nicholas and Brookshires initial study displayed that adults with aphasia performed lower, on average, than non-brain damaged adults, producing less total #CIUs, %CIUs, and #CIUs/Min (Nicholas and Brookshire, 1993; Nicholas and Brookshire, 1995). 2) Measures of CIUs address macrolinguistic measures, such as informativeness and effectiveness (Nicholas and Brookshire, 1993; Nicholas and Brookshire, 1995) and microlinguistic measures such as, #CIUs and #CIUs/Min, which like WPM and total # of

words, can measure linguistic productivity (Stubbs et al, 2018). 3) Those with aphasia have more apparent language deficits, primarily on the microlinguistic level, compared to those with RHD. This is due to the fact that discourse production difficulties in individuals with aphasia are a result of damage to the language dominant hemisphere, compared to individuals with RHD, whose language difficulties are cognitively based (Karaduman et al, 2017; Minga et al, 2021; Stubbs et al, 2018). For these reasons, we predicted that adults with aphasia would perform lower, particularly on #CIUs and #CIUs/Min, as these measures assess microlinguistic and macrolinguistic characteristics of discourse, which are measures of linguistics, not cognition (Karaduman et al, 2017; Stubbs et al, 2018).

As expected, the results exhibit that the two groups had statistically significant differences in the following linguistic measures: #CIUs, #CIUs/Min, and %CIUs. Individuals with aphasia performed significantly lower on all three measures analyzed (#CIUs, #CIUs/Min, and %CIUs). Overall, it can be concluded that the aphasic individuals discourse sample was less accurate, informative, and relevant in relation to the contents of the stimulus material, compared to the discourse produced by individuals with RHD. The individuals with aphasia produced a Cinderella story, when prompted with a wordless picture book, that contained less relevant and accurate information and was less efficient.

Looking at total # of words in addition to %CIUs (total # of CIUs divided by total # of words) can help determine the efficiency of the narrative discourse produced by individuals with aphasia (Nicholas and Brookshire, 1995). The narrative discourse produced by individuals with aphasia was less efficient, demonstrated by lower mean

total # of words (M= 266.33), compared to individuals with RHD (M=432.13) and lower mean WPM (M= 74.39), compared to adults with RHD (M= 134.65). Additionally, the discourse samples from individuals with aphasia were less informative and accurate, indicated by lower mean %CIUs (M= 59%), compared to adults with RHD (M= 78%). Individuals with aphasia in the present study produced fewer words that added to the meaning of the stimulus material in their narrative discourse. This in turn led to discourse that was overall less accurate and informative, indicated by lower %CIUs of the samples.

The combination of overall lower levels of efficiency, informativeness, and accuracy, led to the narrative discourse produced by individuals with aphasia to be less effective overall, compared to adults with RHD. This point can further be demonstrated by looking at #CIUs/Min, which considers efficiency, as well as informativeness and accurateness. The mean #CIUs/Min for adults with aphasia was 48.46, compared to a mean of 105.75 for individuals with RHD. The combined results of this study further support our hypothesis; though both groups have performed lower compared to non-brain damaged adults in separate studies and CIU measures can display the cognitive language deficits that adults with RHD experience (Nicholas & Brookshire, 1993; Nicholas & Brookshire, 1995; Bartels-Tobin & Hinckley, 2005), adults with RHD still have less pronounced and obvious language deficits that individuals with aphasia, shown by their statistically better performance on all measures of CIUs analyzed.

The discourse produced by individuals with RHD is more accurate, informative, and efficient in relation to the topic and contents of the chosen stimulus when compared directly to the discourse difficulties faced by those with aphasia, leading to more effective discourse overall. This is indicated by their higher discourse productivity seen through

WPM, CIUs/Min, and total # of words; accuracy and relevance of discourse produced in relation to the stimulus prompt; and overall effectiveness of narrative discourse.

Though we hypothesized individuals with aphasia would perform lower than individuals with RHD, these findings are still surprising if we conclude that CIUs do in fact measure both the macrostructure and the microstructure to an extent (Brisebois et al, 2021). When taking a closer look at this definition, CIUs emphasize producing discourse that is accurate, relevant, and informative in relation to the topics presented by the discourse elicitation stimulus. Producing discourse that is accurate, relevant. and informative requires the individual producing discourse to have good organizational and topic maintenance skills, which individuals with RHD typically struggle with since their language difficulties are cognitive in nature (Minga et al, 2021). Difficulties with these skills are assumed to affect discourse on the macrolinguistic level (Stubbs et al, 2018; Nicholas and Brookshire, 1993; Nicholas and Brookshire, 1995; Brisebois et al, 2022). For this reason, it is surprising that individuals with RHD performed significantly better on all measures of CIUs than individuals with aphasia, given that they are assumed to perform worse on these measures of macrolinguistics that CIUs may take into account (Karaduman et al, 2018; Brisebois et al, 2018).

However, the importance of discourse elicitation stimuli was previously noted. Those with unilateral brain damage may respond differently to different types of stimuli, depending on which hemisphere their injury occurred and the performance on discourse production tasks of individuals with RHD and aphasic individuals varied depending on the condition used to elicit discourse production (Marini et al, 2005). Narrative discourse is a common measure used to compare the language skills of those with RHD and those

with aphasia (Stubbs et al, 2018). It is thought to be sensitive to the difficulties that individuals with aphasia experience on the microlinguistic level of discourse, as well as the difficulties that individuals with RHD experience on the macrolinguistic level (Karaduman et al, 2019). Though the Cinderella story retelling task is narrative in nature, the TalkBank participants are given a wordless Cinderella book. With this added support while producing narrative discourse, the participants are prompted, by being given external memory cues and organizational support.

For this reason, less work may be needed to organize the discourse being produced, suppress irrelevant information, and stay on topic. By using a wordless picture book to elicit narrative discourse production, the language difficulties that individuals with RHD face on the macrolinguistic level may be minimized. This may be in part why individuals in the RHD group in the present study performed higher on CIU measures, producing more accurate, relevant, and informative narrative discourse than aphasic individuals. Future studies should compare the discourse of individuals with aphasia and individuals with RHD using CIUs and spontaneous or personal narratives.

In conclusion, since individuals with aphasia and individuals with RHD had statistically significantly different performances on CIU measures (#CIUs, #CIUs/Min, and %CIU), we can interpret that CIUs are sensitive measures to detect the difference between the narrative discourse of these two populations when compared directly. Additionally, the current study found that individuals with aphasia performed lower on #CIUs, #CIUs/Min, and %CIUs, compared to individuals with RHD. Individuals with aphasia produced discourse that was less accurate, relevant, and informative in relation to the content and topics of the stimulus used, compared to individuals with RHD. This may

indicate that individuals with aphasia have more obvious language deficits on both levels of discourse, since CIUs have been suggested to measure both the macrolinguistic and microlinguistic levels, though more studies are needed to determine the effect of having a wordless picture book as a prompt during discourse production.

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