Discourse Production and its Relationship to Cognition in Mild Aphasia

by

Marcy D. Edwards

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Department of Communication Sciences and Disorders
College of Behavioral and Community Sciences
University of South Florida

Major Professor: Hana Kim, Ph.D.
Gerald Imaezue, Ph.D.
Christos Salis, Ph.D.

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Abbreviations	Definitions
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WAB-R	Western Aphasia Battery-Revised
AQ	Aphasia Quotient
NABW	Non-aphasic by WAB
SLP	Speech-Language Pathologist
US	United States
CLAN	Computerized Language Analysis Programs
MLU	Mean Length of Utterance
NIA	Neurologically Intact Adults
TVCF	Test of Verbal Conceptualization and Fluency
RUFF	Ruff Figural Fluency Test
NIHTB	National Institutes of Health Toolbox
CTONI-2	Comprehensive Test of Nonverbal Intelligence-Second Edition
DCCST	Dimensional Change Card Sort Test
CIU	Correct Information Unit
ADP	Aphasia Diagnostic Profiles
ASHA	American Speech-Language-Hearing Association
ASHA FACS	ASHA Functional Assessment of Communication Skills for Adults
TEA	Test of Everyday Attention
RSAB	Rating-Scale of Attentional Behavior
BIT	Behavioral Inattention Test
OTMT	Oral Trail Making Test
RQ	Research Question
ANOVA	Analysis of Variance
CLQT+	Cognitive Linguistic Quick Test+
L	Linguistic
NL	Nonlinguistic
TEA-VE	Test of Everyday Attention-Visual Elevator
TTR	Type-Token Ratio
PBJ	Peanut Butter and Jelly
MATTR	Moving-Average Type-Token Ratio

Abstract

Objective:

Standardized assessments such as the Western Aphasia Battery-Revised do not reliably detect subtle language impairments in mild aphasia (Dalton & Richardson, 2015). Discourse tasks may provide a more sensitive measure of impairment. Although discourse tasks differ in cognitive demands (Kim & Kintz, 2024), variation in discourse performance across tasks and the influence of cognition remains unclear. Therefore, this study examined (1) whether discourse performance differs across different discourse elicitation tasks, and (2) the extent to which cognition influences discourse performance in individuals with mild aphasia.

Participants & Methods:

Fifteen participants with mild aphasia participated (mean age = 62.7 years). Discourse samples were elicited using sequential picture, storytelling, and expository tasks and analyzed using a multi-level linguistic analysis framework (Marini et al., 2011). Cognitive measures assessed working memory, short-term memory, inhibition, cognitive flexibility, and attention.

Results:

Friedman tests showed no significant differences in micro-level discourse errors across tasks. However, significant differences were found in macro-level discourse errors. Post hoc Wilcoxon signed-rank tests showed significantly more macro-level errors during expository tasks than storytelling tasks with a large effect size and more errors during sequential picture tasks than storytelling tasks with a large effect size. Spearman's correlations demonstrated significant relationships between discourse performance and cognitive performance. At the micro-level, working memory, cognitive flexibility, and attention were associated with storytelling and expository tasks, while working memory and cognitive flexibility were associated with

sequential picture tasks. At the macro-level, cognitive flexibility and attention were associated with storytelling and sequential picture tasks.

Conclusion:

Discourse production in mild aphasia varied by discourse task type, particularly at the macro-linguistic level. Storytelling tasks resulted in fewer macro-level errors than expository and sequential picture tasks. These findings suggest that macro-level discourse performance is task-sensitive in this population. Cognitive abilities were associated with both micro- and macro-level discourse performance, indicating that cognition contributes to lexical retrieval as well as higher-level discourse planning and monitoring processes.

Chapter One: Introduction

Aphasia is defined as a communication deficit commonly resulting from stroke or traumatic brain injury. Roughly two million Americans are affected by aphasia (National Aphasia Association, n.d.), with common characteristics being impaired speech production, reduced understanding of language, and cognitive deficits. Individuals with aphasia may experience difficulty with attention, memory, and executive functioning, which impacts their ability to communicate effectively with others in day-to-day conversations (Cruice et al., 2006; Cavanaugh et al., 2020). The current study specifically focuses on individuals with mild aphasia, characterized by fluent, meaningful speech and mild language impairments resulting from neurological conditions such as stroke.

Mild aphasia

Individuals with mild aphasia demonstrate varying degrees of severity across language and cognitive deficits, making it difficult to define. Currently, there is no single, universally accepted definition of mild aphasia in the field of aphasiology. According to the Western Aphasia Battery-Revised (Kertesz, 2007), individuals who score between 76 and 93.8 are typically classified as having mild aphasia. In research, mild aphasia is used to describe individuals who have word-finding difficulties and reduced processing speeds (Hickin et al., 2015). However, the term *mild aphasia* has also been used to describe individuals below, at, or above the WAB-R cutoff of 93.8 (Fox et al., 2009) (this specific type of mild aphasia will be discussed in more detail below).

While these deficits are classified as "mild", this group often remains overlooked in healthcare settings (Satoer et al., 2022) as their symptoms are subtle and may not be readily apparent to clinicians. General characteristics of mild aphasia include communication difficulties observed at the word, sentence, and discourse levels, and impairments in attention, executive functioning, short-term memory, and working memory (Cruice et al., 2006; DeDe & Salis, 2020; Dutta et al., 2024; Hickin et al., 2015; Murray, 2012), which can pose significant impacts on quality of life.

The challenge in diagnosing and providing care for individuals with mild aphasia is not new. A roundtable discussion at the Clinical Aphasiology Conference in 1980 examined how standardized tools were inaccurate in diagnosing and treating “high-level” linguistic capabilities in persons with aphasia (Darley et al., 1980). More recently, a roundtable discussion at the International Aphasia Rehabilitation Conference in 2016 examined the lack of standardized testing that is sensitive in accurately diagnosing mild aphasia (Hicken & Dipper, 2016). The discussion illuminated the poor reflectivity of real-world linguistic difficulties and cognitive demands in standardized assessments.

In a recent survey study including 133 speech-language pathologists (SLP) working in the US (Mozeiko & Pascariello, 2020), clinicians reported using informal measures more frequently than standardized assessments when assessing clients with mild aphasia. Only 22 respondents reported an “overall greater focus on cognitive assessment”. The survey also found that the main factors that preclude individuals with mild aphasia to being assessed are (from greatest to least impact): no referral from healthcare provider, patient/family denial of deficits, insurance barriers, medical complications, no presence of deficits identified by screening measures, premature discharge from facility, and cognitive deficits.

Non-aphasic by WAB

Similarly, but notably less recognized, are individuals who score at or above an AQ of 93.8 on the WAB-R. These individuals are generally considered “normal” or “non-aphasic” according to the WAB-R test manual (Kertesz, 2007, p. 91). This group often shows subtle yet apparent deficits in language despite a non-aphasic classification (Fromm et al., 2016). Literature refers to this population by a variety of names, such as *residual aphasia* (Chesneau & Ska, 2014), *non-aphasic by WAB-R score* (Dalton & Richardson, 2015; Fromm et al., 2016), *latent aphasia* (DeDe & Salis, 2020; Salis & DeDe, 2022), and *mild aphasia* (Fox et al., 2009). As this study focuses on the underdiagnosed mild form of aphasia, it will also include individuals who are classified as non-aphasic and have a history of stroke and language complaints within its scope. When it is necessary to specify this particular group, the term "non-aphasic by WAB (NABW)" will be used throughout this manuscript. For the purpose of this study, the umbrella term "mild aphasia" will refer to all individuals who score 76 and above on the WAB-R.

Cavanaugh et al. (2020) provided additional evidence of the overall impact of mild aphasia on quality of life. The authors reported that individuals with mild aphasia exhibited a "self-awareness of speech and language abilities" (p. 443) during communication, and four out of five of the participants reported needing greater preparation and focused attention for daily communication. Participants also commented on difficulties with multitasking since their stroke. Other frustrations expressed by participants were difficulties with word selection, struggling to express themselves during arguments/debates, disfluencies while speaking, difficulties with typing on a computer, and overall reduced social participation. Without properly addressing these feelings and communication deficits, it can be difficult for individuals with mild aphasia to regain confidence in their daily interactions with others.

Armstrong et al. (2013) sought to gain a deeper understanding of the impacts of mild aphasia using four 10-minute conversations with a familiar partner (i.e., husband) while prompting the participant to initiate topics, indicate linguistic difficulties with a comment, ask more questions, and slow their rate of speech. The results found that the participant with mild aphasia expressed simplified arguments, omitted specific words in favor of general terms, and failed to elaborate on ideas, often relying on her husband to facilitate the conversation. Even though the participant exhibited clear linguistic deficits in discourse as revealed by multi-level analysis (Marini et al., 2011), the WAB classified her at the standard cutoff for an aphasic classification with an AQ of 93.8. Thus, the participant was categorized as roughly "normal." This finding underscores the necessity for more sensitive assessment tools to identify the communication challenges associated with mild aphasia in clinical settings, as standardized measures are often inadequate for this population. Because individuals often categorized as NABW are underrepresented in research despite consistently reporting communication difficulties, the current study includes participants classified as having mild aphasia based on the WAB-R, while also meeting criteria for NABW. For clarity, the umbrella term *mild aphasia* will be used throughout the remainder of the study.

Discourse in mild aphasia

Researchers and clinicians agree that standardized tests like the WAB-R are limited in their sensitivity in reliably detecting mild impairments (e.g., Armstrong et al., 2013; Cavanaugh et al., 2020; DeDe & Salis, 2020; Ross & Wertz, 2003). A potentially more sensitive measure in capturing linguistic deficits in persons with mild aphasia is through discourse tasks (Armstrong et al., 2013; Fromm et al., 2016; Marini et al., 2011; Jaecks et al., 2012). Discourse is defined as language that extends isolated sentences (Ulatowska & Olness, 2004) and is known to reflect everyday communication, which is fundamental to completing daily activities (Linnik et al., 2015).

A study by Fromm et al. (2016) analyzed data from the AphasiaBank database (MacWhinney et al., 2011) by dividing the groups into 27 participants who were NABW, 87 participants with anomic aphasia (i.e., AQ of 76 to 93.8), and 177 healthy controls. In this study, transcriptions of the participants telling the Cinderella narrative were analyzed using Computerized Language Analysis Programs (MacWhinney et al., 2000). The results found that the NABW group was significantly different in words per minute, percent word errors, lexical diversity, main concept production, and number of utterances; however, no significant differences were found in mean length of utterance or proposition density (i.e., number of ideas). The anomic aphasia group was found to differ significantly from controls on all levels. The NABW group differed significantly from the top scoring anomic participants on all measures except total utterances and main concepts. The authors discussed the notion that the NABW population has been underserved despite performing significantly differently in discourse compared to their healthy counterparts. Furthermore, the NABW population deserves consideration for the benefits from increased attention in research and treatment. Consequently, discourse analysis was found to be more sensitive than the use of the WAB-R alone.

Dalton and Richardson (2015) investigated core lexicon scores (i.e., the most common words used to tell a story) and main concept scores (i.e., providing relevant information regarding the stimulus) in persons with aphasia. The study used AphasiaBank data from 235 participants with varying severities of aphasia, 97 of which were considered mild, and 92 healthy controls. Language samples were obtained from a picture description task. The authors found that all individuals with aphasia scored significantly differently than healthy controls in both core lexicon and main concepts. Participants who were NABW had significantly different scores in only core lexicon when compared to participants with anomic and conduction aphasia; however, they did score significantly differently in both core lexicon and main concepts when compared to participants with severe aphasia (i.e., Wernicke's aphasia).

Harmon et al. (2024) examined how cognitively and socially demanding situations impacted micro- and macro-level linguistic productions in 30 people with mild, moderate, and severe aphasia using story retelling tasks. During the dual-task condition (i.e., retell a story while simultaneously differentiating high and low tones), participants with mild aphasia generally maintained overall cohesiveness and coherence (i.e., sentence-level features) but exhibited reduced word productivity and lexical diversity (i.e., word-level features). The authors hypothesized that during tasks which taxed cognitive capacity, participants with mild aphasia experienced a tradeoff by exhibiting a greater number of microlinguistic (i.e., word-level) errors to compensate for the additional cognitive load.

Jaecks et al. (2012) investigated using spontaneous speech (i.e., the spontaneous speech subtest in the Aachen Aphasia Test) as an assessment tool for mild aphasia. The study consisted of 41 participants with mild aphasia and 25 healthy controls. Language samples were transcribed and scored on a scale for the following categories: communicative behavior, articulation and prosody, formulaic/automatic language, semantics, phonology, and syntax. Their findings showed that the main characteristics of mild aphasia varied across word-finding difficulties, semantic paraphasias, and phonemic instabilities, thus demonstrating that discourse was effective in detecting subtle differences in language between mild aphasia and healthy controls.

Andreetta et al. (2012) investigated discourse in 10 participants with anomic aphasia and 10 healthy controls. Participants produced narrative stories when describing pictures which were later analyzed at the word-level, sentence-level, and informativeness-level. The authors found that the anomic group produced overall fewer utterances, more errors in cohesion and global coherence (i.e., how well the utterances were on theme with the stimulus), a greater amount unnecessary words, repetitions, and tangential speech than the control group.

Stark (2019) sought to identify differences in linguistic variables (MLU, verbs per utterance, TTR, words per minute, propositional density, noun-verb ratio, open-closed class word ratio, and tokens) across discourse tasks. The author utilized four different discourse tasks (retelling the story of *Cinderella*, explaining how to make a peanut butter and jelly sandwich, a sequential picture, and a single picture) in 90 persons with varying severity levels of aphasia, compared to 84 healthy controls. For obtaining discourse samples, the author used AphasiaBank. Significant findings revealed that different discourse elicitation tasks produced distinct linguistic performance profiles in both groups, supporting the idea that different discourse task types elicit varying levels of cognitive-linguistic demand.

In a study by Fergadiotis & Wright (2011), the authors examined lexical diversity in discourse samples from 25 persons with mild to moderate aphasia (i.e., anomic or conduction aphasia as defined by the WAB-R) and 27 neurologically intact adults (NIA). Discourse samples were obtained from AphasiaBank and included different discourse tasks: sequential pictures, single pictures, and telling the story of *Cinderella*. The authors found significant results in that the NIA group demonstrated higher levels of lexical diversity across all discourse tasks with storytelling showing higher levels than sequential pictures. Both groups significantly yielded the lowest levels of lexical diversity in the single pictures task. However, persons with aphasia demonstrated similar levels of lexical diversity for storytelling and sequential pictures. Further comparisons found that the mean difference in lexical diversity for the storytelling task was significantly larger between NIA and persons with aphasia when compared to the other discourse tasks. Persons with aphasia showed a significantly lower level of lexical diversity than the NIA group in storytelling when compared to sequential pictures. The authors suggest that these findings support the notion that discourse tasks without pictorial employ higher cognitive-linguistic demands for persons with aphasia.

Role of cognition in discourse in mild aphasia

While there is a lack of studies focusing on the role of cognition in discourse in mild aphasia specifically, research has suggested that individuals with varying severity levels of aphasia experience deficiencies in executive functioning (Dutta et al., 2024; Dutta et al., 2023), attention (Murray et al., 2017), working memory (Mayer & Murray, 2012), and processing speed (DeDe & Salis, 2020). It has been established that story generation and story retelling tasks incorporate both linguistic and nonlinguistic cognitive components such as working memory, inhibition, cognitive flexibility, initiation and planning, reasoning and problem solving, and self-awareness (Dutta et al., 2024; Coelho, 2002; Lindsey et al., 2018; Marini et al., 2011). Studies suggest that linguistic difficulties in individuals with mild aphasia may result from decreased cognitive function (Chesneau & Ska, 2014; Fox et al., 2009; Frankel et al., 2007; Hickin et al, 2011). However, existing research has insufficiently examined the relationship between discourse and cognitive performance in persons with specifically mild aphasia. Given the lack of research in this area, the present study will explore various cognitive components (i.e., working memory, inhibition, cognitive flexibility, attention, and short-term memory) and their respective relationships to discourse in mild aphasia.

A recent study by Dutta et al. (2024) investigated the role of executive functioning in persons with mild to severe aphasia. Story retelling was used to elicit narrative discourse samples from participants. Participants were presented with a wordless picture book, then instructed to retell the story without the book in front of them. Nonverbal executive functioning tasks included numeric-alphabetic trails (i.e., Test of Verbal Conceptualization and Fluency [TVCF-Trails C; Reynolds & Horton, 2007]), figure drawing (i.e., Ruff Figural Fluency Test; Ruff, 1988, 1996), figure matching/identification (i.e., National Institutes of Health Toolbox [NIHTB; Zelazo et al., 2013]; Comprehensive Test of Nonverbal Intelligence-Second Edition [CTONI-2; Hammill et al., 2009]), and card sorting (i.e., NIHTB-Dimensional Change Card Sort Test [DCCST]). Verbal executive functioning tasks included list sorting (i.e., NIHTB-List Sorting [LS]), number of correctly counted strings (i.e., Test of Everyday Attention), figure identification (i.e., CTONI-2), and word generation (i.e., TVFC-Categorical Fluency [CF] and Letter Naming [LN]). The authors found that the aphasia group (n = 22; varying levels of severity) demonstrated greater difficulty with verbal executive functioning tasks than non-verbal executive functioning tasks when compared to healthy controls (n = 24). Notably, correlations between both verbal and nonverbal executive functioning tasks and narrative skills were found in the aphasia group. The authors found that productivity (e.g., total words, total utterances, etc.), informational content and efficiency (e.g., Correct Information Units [CIUs], CIUs/min and %CIUs), and grammatical skills (e.g., %grammatically complex utterances, etc.) were related to performance on verbal and nonverbal executive functioning tasks that measured processing speed, verbal fluency, planning, visual and auditory working-memory, inhibition, cognitive flexibility, analogical reasoning, and self-monitoring. The results indicate the involvement of executive functioning in narrative discourse tasks. The study's sample included some individuals with mild aphasia (n = 10). However, due to the small sample size, the authors did not conduct a separate analysis by severity of aphasia. Thus, it is not possible to specify the role of executive functions in narrative skills in mild aphasia specifically.

Murray (2012) sought to determine if a relationship existed between cognitive performance, specifically attention, and aphasia, and if attentional deficits impacted communication function. A total of 39 adults with varying severity levels of aphasia and 39 healthy controls participated in the study. To examine communication function, the Aphasia Diagnostic Profiles (ADP; Helm-Estabrooks, 1992) and American Speech-Language-Hearing Association (ASHA) Functional Assessment of Communication Skills for Adults (ASHA FACS; Frattali et al., 1995) were used. The study utilized the TEA and the Rating-Scale of Attentional Behavior (RSAB; Ponsford & Kinsella, 1991) to assess attention; the Behavioral Inattention Test (BIT; Wilson et al., 1987) was administered to identify the presence of visual neglect; and the Ruff Figural Fluency Test (RUFF; Ruff, 1996) assessed nonverbal executive functions (e.g., self-monitoring, planning, and cognitive flexibility). Results found that the aphasia group performed worse than the control group across all the attention measures. Of note, associations were found between performance on attention measures and overall communication and language abilities in persons with aphasia.

Although evidence exists regarding the relationship between discourse performance and cognitive underpinnings, our knowledge remains fragmented regarding mild aphasia. Explanations for why our understanding is lacking in this area could be contributed to the small number of studies on mild aphasia, varying discourse tasks and measures used in research and assessment, and varying cognitive tests on different domains.

Therefore, this research focuses on identifying the relationship between discourse performance and cognitive impairments in mild aphasia. To the best of our knowledge, this is the first prospective study to specifically focus on mild aphasia. Given the exploratory nature of this study and the limited number of prior studies on cognitive impairment in mild aphasia, a variety of cognitive tests have been selected to measure attention, memory, and executive functions.

Research questions

The aim of this study is to answer the following two research questions:

1. Are there significant differences in discourse production in individuals with mild aphasia across different discourse tasks?
2. Are there significant relationships between discourse production and cognition in individuals with mild aphasia?

In the current study, two different types of discourse tasks will be used: narrative (e.g., storytelling and sequential picture description) and expository (e.g., response to controversial questions) discourse tasks. For the first research question, I hypothesized that mild aphasia would result in more errors in expository discourse tasks than in narrative discourse tasks, based on previous work by Fergadiotis & Wright (2011), Kim et al. (2024), and Stark (2019). For the second research question, I hypothesized that reduced cognition (i.e. attention, working memory, short-term memory, cognitive flexibility, and inhibition) is associated with greater errors in discourse production.

Chapter Two: Methods

Participants

Fifteen persons with mild aphasia participated in the current study. To be included in this study, participants had to be over the age of 18, have a history of stroke (at least 6 months post-onset), have English as their first language, have a score of 76 or above on the Western Aphasia Battery-Revised, and demonstrate a functional level of hearing and visual acuity (either corrected or uncorrected). Individuals were excluded if they had a history of other neurological (e.g., head trauma, progressive diseases), psychiatric, and/or developmental language disorders (e.g., dyslexia) per medical documentation or self-report. The present study recruited 17 participants; however, one participant's data was excluded due to a confirmed history of developmental dyslexia, and another participant elected to not complete the testing. In total, 15 participants were included in this study. Participant demographics are listed below in Table 1.

Table 1. Participant Demographics

ID	**Age at testing (mean = 62.7 years; range = 46–77)**	**Gender (M = 11)**	**Education (mean = 17.1 years)**	**Time post-onset stroke (months)**	**AQ (mean = 92.12)**	**Aphasia type (WAB-R; NABW = 6)**
AMP001	61	M	16	60	98	NABW
AMP002	57	M	12	10	93.7	Anomic
AMP003	53	M	16	13	91.1	Anomic
AMP004	70	F	16	47	94	NABW
AMP005	65	M	20	42	94.6	NABW
AMP006	77	M	16	73	88.1	Anomic
AMP007	64	M	18	252	91.1	Anomic
AMP008	56	M	16	66	91.8	Anomic
AMP010	55	M	20	62	91.9	Anomic
AMP012	77	F	16	56	82.5	Anomic
AMP013	65	M	18	101	96.4	NABW
AMP014	64	F	18	58	95.2	NABW
AMP015	46	F	18	43	87	Anomic
AMP016	75	M	16	104	86.8	Anomic

Table 1. Continued

AMP017	56	M	20	48	99.6	NABW

Note. AQ = Aphasia Quotient; WAB-R = Western Aphasia Battery-Revised; NABW = non-aphasic by WAB.

Testing procedure

Testing sessions were conducted remotely over Microsoft Teams with test stimuli being presented either via the screenshare feature or verbally by the examiner. Participants completed a background history form prior to the WAB-R, cognitive testing, and narrative discourse tasks. Participants were offered to complete testing over 1 to 2 days with each session taking up to 3 hours. For discourse tasks, narrative and expository discourse samples were elicited through prompts (i.e., “Tell me a story explaining what is happening in this picture.”; “Are you for or against homeschooling? Please explain why.”). Participants’ discourse samples were recorded, then transcribed and analyzed with multi-level linguistic analysis (Marini et al., 2011). Discourse tasks were not timed and did not have a time limit. Cognitive measures included various linguistic and non-linguistic tests (see Table 2 for a complete list). For cognitive tasks measuring reaction time only (see Table 2), participants were limited to 5-minutes. All measures were divided into three sections (Background Form with WAB-R Administration, Cognitive Tasks, and Discourse Tasks), and the administration order of each section and individual task was randomized.

Table 2. Cognitive Measures

Cognitive Domain	Task	L or NL	Task Description	Outcome Measures
Working memory	Tompkins Listening Span	L	Immediately after hearing a sentence, judge whether it was true or false, and retain the final word of each sentence for spoken recall after the entire set has been presented. Set difficulty increases over time from 2 sentences per set to 3 sentences per set, and so on (Tompkins et al., 1994).	Total correct responses (accuracy)
	Digit Span Backward (WAIS subtest)	L	Repeat a series of numbers.	Total correct responses (accuracy)
Inhibition	Hayling Sentence Completion Test	L	Section 1: Listen to and complete each sentence with the fitting word. Section 2: Listen to and complete each sentence with a word that does not fit (Burgess & Shallice, 1996).	Section 1: Initiation response latencies (simple response initiation); Section 2: Suppression time (participant efficiency) and Suppression total correct responses (accuracy)

Table 2. Continued

Cognitive flexibility	Generative Naming (CLQT+ subtest)	L	Part 1: Name as many animals as possible. Part 2: Name as many words that start with the letter "m" as possible, excluding proper nouns, places, and iterations of the same verb (Helm-Estabrooks, 2017).	Total correct responses (accuracy)
	Oral Trail Making Test (OTMT: Part A)	NL	Count from 1 to 25 as quickly as possible. Part B: Count from 1–25 while switching between number and letter, "1-A-2-B-3-C" and so on (Ricker & Axelrod, 1994).	Reaction time
Attention	Story retelling (CLQT+ subtest)	L	Listen to and retell a short story as accurately as possible.	Total correct responses (accuracy)
	Visual Elevator (Test of Everyday Attention: Subtest 4)	NL	Count the elevator images and say the number that the set ends on based on the "up" or "down" arrows as quickly as possible (Robertson et al., 1996).	Total correct responses (accuracy) and reaction time

Table 2. Continued

Short-term memory	Digit Span Forward (WAIS subtest)	L	Repeat a series of numbers.	Total correct responses (accuracy)
	Camden Facial Recognition	NL	Identify faces (out of binary choices) that were previously encoded.	Total correct responses (accuracy)

Note. Cognitive assessments. L = linguistic; NL = non-linguistic. Tasks with higher total correct responses indicate better cognitive performance, whereas higher reaction time outcomes indicate worse cognitive performance.

Discourse tasks

The current study used narrative and expository discourse tasks. For the narrative task, two wordless picture books and two sequential pictures were utilized. The first wordless picture book, "Picnic" by McCully (2003), depicts a family of mice gathering for a picnic in the park, but one of the mice falls out of the truck and is left behind. The mice family searches and eventually finds the lost mouse. The second wordless picture book, "Good Dog, Carl" by Day (1985), depicts a mother leaving her dog to babysit her young child. The two explore various rooms in the house and make a large mess. The dog proceeds to bathe the baby, return him to the crib, and clean up the house before the mother returns. The examiner introduced the task (i.e., "I will ask you to make stories based on picture books.") and provided an example using a separate picture book, "The Great Ape" by Krahn (1978). Then, the examiner prompted the participant to look through the pages of the stimulus. Once the participant was ready to begin, the examiner gave a prompt (i.e., "Tell me a story that has a beginning, a middle, and an end.").

Two picture sequences developed by Nicholas & Brookshire (1993), "Argument" and "Directions", were included in the protocol. The six-frame picture sequence "Argument" depicts a husband and wife arguing. The wife proceeds to pack her bag and leave, but she crashes her car into a tree and returns to her husband, and they resolve their fight with a hug. The other six-frame picture sequence “Directions” depicts a young couple driving in a convertible. They stop next to a farmer on the side of the road and ask for directions before driving away. Having been given presumably poor directions, the couple returns to the farmer. The examiner first provided an example of a picture description using “Cookie Theft” by Nicholas & Brookshire (1993). Then, participants were prompted to look at the pictures and tell a linear story explaining what is happening (i.e., “I am going to show you a series of pictures. First take a moment to look at them. Once you are ready, tell me a story that has a beginning, a middle, and an end.”).

For the expository tasks, participants were asked to answer two controversial questions. Expository discourse is considered as a more cognitively challenging task compared to narrative discourse tasks (Kim et al., 2024). The examiner provided an example argument (i.e., arguing for the separation of church and state), then prompted the participant to construct an argument for or against each topic. The selected questions were related to healthcare system and homeschooling. The two questions were: “Do you believe healthcare is a right or privilege? Please explain why.” and “Are you for or against homeschooling? Please explain why.” If the participant did not provide a sufficient response (i.e., two or less utterances; no clear stance given during the expository discourse task) then the examiner gave an additional prompt (i.e., “Is there anything else you would like to add?”).

Discourse analysis

Transcription procedures

Language samples were transcribed orthographically in Computerized Language Analysis Programs (CLAN; MacWhinney et al., 2000) and segmented based on the rules of C-

Segmentation (Loban, 1976). Intra- and inter-rater reliability was conducted on twenty percent of randomly selected language samples for the number of micro- and macro-level errors. Two trained research assistants helped with inter-rater reliability. For transcriptions and combined micro- and macro-level errors, there was 93.85% agreement for intra-rater reliability, and 97.06% agreement for inter-rater reliability.

Multilevel discourse analysis

Discourse involves complex, multilevel processing, encompassing both microlinguistic and macrolinguistic features. Multilevel error analysis, developed by Marini and colleagues (2011), has been shown to be effective in detecting sensitive changes in discourse over time in individuals with language deficits caused by aphasia (Marini et al., 2011) and traumatic brain injury (Kintz et al., 2018). This approach examines both the structure and function of linguistic processing through noting errors in productivity, lexical and grammatical processing, narrative organization, and informativeness. Both microlinguistic and macrolingustic levels are analyzed in this approach. The microlinguistic level focuses on errors found within the utterance (i.e., word-level) through analysis of phonology, lexicon, morphology, and syntax (Brownell, 1988). This includes false starts, phonological errors, neologisms, lexical fillers, rephrasals, repetitions, semantic errors, placeholder words, substitution of function words, substitution of morphemes, and ambiguous referents. The macrolinguistic level focuses on the entire utterances through analysis of cohesion, coherence, and completeness (Agar & Hobbs, 1982; Glosser & Deser, 1990). This includes utterance fillers, repetitions of utterances, conceptually incongruent utterances, and tangential utterances. All errors were converted into percentages by error type. See Table 3 for definitions of micro- and macro-levels of linguistic errors.

Table 3. Multilevel Linguistic Errors

Linguistic level	Error type	Definition
Micro	False starts	A word is not finished and left as a non-word sound unit.
	Phonological Errors	Sounds in a word are added, missed, or substituted to create a word or non-word with at least half the sound segments intact.
	Neologisms	A substitution of a word for a non-word that does not meet phonological paraphasia criteria.
	Lexical Fillers	Words used to signal that the speaker is holding the floor or processing information that do not add information to the narrative.
	Rephrasals	A word or phrase is rephrased or restructured.
	Repetitions	A word or phrase is repeated.
	Semantic Errors	A word is replaced with a semantically related word, or a word is substituted for a real word that does not fit the description of a phonological error.
	Placeholder Words	A word that temporarily refers to people, places, or things that is often used when a lexical item is forgotten.
	Substitution of Function Words	A function word is substituted for another function word that does not fit syntactically or semantically.
	Substitution of Morphemes	A bound morpheme is replaced or absent. The new morpheme does not fit syntactically or semantically with the utterance.
	Ambiguous Referents	A reference word, usually a pronoun, does not have an obvious referent.

Table 3. Continued

Macro	Utterance Fillers	An utterance that is used to signal that the speaker is holding the floor or processing information.
	Repetitions of Utterance	An utterance that has its semantic information repeated again in another utterance.
	Conceptually Incongruent Utterances	An utterance does not go along with the stimuli.
	Tangential Utterances	An utterance that is off-topic, not about the stimuli.

Statistical approach

To answer the first research question, Friedman tests were conducted to find statistically significant differences across discourse tasks in individuals with mild aphasia. To answer the second research question, Spearman's correlational coefficients were used to examine the relationship between discourse production and cognition.

Chapter Three: Results

RQ 1

A Friedman test showed no statistically significant differences in percentage of micro-level discourse errors across discourse task types, $\chi^2(2) = 3.733$, $p = .155$. However, a statistically significant difference was found in percentage of macro-level discourse errors across discourse task types, $\chi^2(2) = 10.610$, $p = .005$. As a post hoc analysis, Wilcoxon signed-rank tests revealed statistically significant differences in the percentage of macro-level discourse errors between expository and storytelling tasks ($Z = -2.365$, $p = .017$) with a large effect size ($r = .61$). These findings indicate that individuals with mild aphasia produced a higher percentage of macro-level errors during expository discourse tasks compared to storytelling tasks. Significant differences were also found in the percentage of macro-level discourse errors between sequential pictures and storytelling tasks ($Z = -1.977$, $p = .048$) with a large effect size ($r = .51$). These findings indicate that individuals with mild aphasia produced a higher percentage of macro-level errors during sequential pictures tasks compared to storytelling tasks.

Micro- and macro-level errors were totaled and converted to percentages, respectively. Means and standard deviations for micro- and macro-level errors by task are presented in Table 4.

Table 4. Discourse Error Percentages

Discourse Task	**Linguistic Errors**	**Mean (min-max)**	**Std. Deviation**
Storytelling	Micro	16.26% (2.86%-36.28%)	12.39
	Macro	14.26% (0%-40.0%)	12.58
Sequential pictures	Micro	19.26% (1.76%-39.9%)	12.64
	Macro	24.2% (0%-75%)	24.54

Table 4. Continued

Expository	Micro	15.27% (2.01%-35.39%)	9.78
	Macro	31.91% (0.00%-107.69%)	28.60

RQ 2

Spearman's rank-order correlations were run to determine the relationship between discourse performance, and linguistic and nonlinguistic cognitive scores. Each cognitive measure, except the OTMT, produced a total correct response score, which was used in the analyses. For the OTMT, Hayling Sentence Completion Test, and TEA-VE time tasks, reaction time was also used as an outcome measure. For all test scores, higher total correct response values indicate better cognitive performance. For the Hayling Sentence Completion Test, OTMT, and TEA-VE, higher reaction times indicate worse cognitive performance. Means and standard deviations for cognitive performance are presented in Table 5.

Table 5. Cognitive Scores

Cognitive Domain	**Task**	**Mean**	**Std. Deviation**
Working memory	Tompkin's Listening Span	60.36 (50–73)	7.52
	Digit Span Backward	1.967 (0–4)	1.11
Inhibition	Hayling Initiation Response Latencies (seconds)	52.87s (22.4s–165.24s)	38.01
	Hayling Suppression Time (seconds)	104.73s (29.35s–189.36s)	53.34
	Hayling Suppression Raw Score	12.87 (7–15)	2.75
Cognitive flexibility	Generative Naming (CLQT+)	4.87 (2–9)	1.81
	OTMT (seconds)	188.95s (73s–273.65s)	61.18

Table 5. Continued

Attention	Story Retelling (CLQT+)	5.73 (3–9)	1.88
	TEA-VE (seconds)	4.14s (0s–11.53s)	3.57
	TEA-VE (score)	5.20 (0–10)	4.20
Short-term memory	Camden's Facial Recognition	23.07 (18–25)	2.15
	Digit Span Forward	3.433 (1–6)	1.18

Micro-level errors

For working memory, moderate, negative correlations were found between the Digit Span Backward score and micro-level errors in storytelling (r = -.656, p = .01) and expository (r = -.580, p = .05) discourse tasks. This indicates that individuals with higher Digit Span Backward scores produced a lower percentage of micro-level errors in storytelling and expository discourse tasks. For cognitive flexibility, strong to moderate, negative correlations between Generative Naming performance and discourse production were found at the micro-level in storytelling (r = -.718, p = .01), expository (r = -.692, p = .01), and sequential picture (r = -.630, p = .05) tasks. These findings indicate that individuals who scored higher on the Generative Naming task produced a lower percentage of microlinguistic-level errors. Strong, positive correlations were found between the OTMT and discourse production at the micro-level in storytelling (r = .883, p = .01) and expository (r = .783, p = .05) tasks. This indicates that individuals who took longer to complete the OTMT produced a higher percentage of micro-level errors. For attention, strong, negative correlations between the TEA-VE accuracy scores and discourse production were found at the micro-level in storytelling (r = -.847, p = .01), expository (r = -.716, p = .01), and sequential picture (r = -.824, p = .01) tasks, indicating that individuals who scored higher on the TEA-VE task produced a lower percentage of micro-level errors. Moderate, negative correlations between the TEA-VE time scores and discourse production were statistically significant at the micro-level in storytelling ($r = -.524$, $p = .05$), expository ($r = -.516$, $p = .05$), and sequential picture ($r = -.586$, $p = 0.05$) tasks. This indicates that individuals who were faster at completing the TEA-VE task produced a lower percentage of micro-level errors.

Table 6. Micro-level Discourse and Cognitive Correlations

Cognitive Domain	**Cognitive Measure**	**Discourse Task**		
		Storytelling	**Expository**	**Sequential Pictures**
Working memory	Tompkin's Listening Span	-0.296	-0.363	-0.407
	Digit Span (Backward)	-.656**	-.580*	-0.466
Inhibition	Hayling Initiation Response Latencies	0.089	0.2	0.232
	Hayling Suppression Time	0.171	0.314	0.411
	Hayling Suppression Raw Score	0.187	0.095	-0.141
Cognitive flexibility	Generative Naming	-.718**	-.692**	-.630*
	OTMT (Time)	.883**	.783*	.767*
Attention	TEA (Score)	-.836**	-0.632	-.675*
	TEA (Time)	0.091	0.006	-0.079
	Story retelling (CLQT+)	-0.315	-0.223	-0.507
Short-term memory	Camden Facial Recognition	0.102	0.165	0.18
	Digit Span (Forward)	-0.509	-0.405	-0.243

Note. Values are Spearman's rho correlations. * $p < .05$. ** $p < .01$.

Macro-level errors

For cognitive-flexibility, moderate, negative correlation was found between Generative Naming and discourse production in storytelling tasks ($r = -.627$, $p = .05$), indicating that individuals who scored higher on the Generative Naming task produced a lower percentage of macro-level errors. Strong, positive correlations were found with the OTMT and discourse production in storytelling (r = .700, p = .05) and sequential picture tasks (r = .767, p = .05). This indicates that individuals who took longer to complete the OTMT produced a higher percentage of macro-level errors. For attention, strong, negative correlations between the TEA-VE accuracy scores and discourse production were found in storytelling (r = -.719, p = .01) and sequential pictures (r = -.580, p = .05), indicating that individuals who scored higher on the TEA-VE task produced a lower percentage of macro-level errors.

Table 7. Macro-level Discourse and Cognitive Correlations

Cognitive Domain	**Cognitive Measure**	**Discourse Task**		
		Storytelling	**Expository**	**Sequential Pictures**
Working memory	Tompkin's Listening Span	-0.339	-0.075	-0.224
	Digit Span (Backward)	-0.454	-0.143	-0.259
Inhibition	Hayling Initiation Response Latencies	-0.182	-0.159	-0.079
	Hayling Suppression Time	0.121	0.218	0.143
	Hayling Suppression Raw Score	-0.03	0.207	-0.006
Cognitive flexibility	Generative Naming	-.627*	0.045	-0.314
	OTMT (Time)	.700*	-0.133	0.477
Attention	TEA (Score)	-.867**	0.25	-0.414
	TEA (Time)	0.176	-0.503	-0.079
	Story retelling (CLQT+)	-0.441	-0.016	-0.319
Short-term memory	Camden Facial Recognition	-0.106	-0.003	0.138
	Digit Span (Forward)	-0.483	-0.266	-0.187

Note. Values are Spearman's rho correlations. * $p < .05$. ** $p < .01$.

Chapter Four: Discussion

Key findings

The study sought to determine if (1) there are significant differences in discourse production in individuals with mild aphasia across different discourse tasks, and (2) there are significant relationships between discourse production and cognitive performance in individuals with mild aphasia. To my knowledge, this is the first study to examine both linguistic and non-linguistic cognitive tasks in individuals with mild aphasia specifically.

Performance across discourse tasks

At the micro-level, there was no statistically significant difference across different discourse tasks (e.g., storytelling, sequential pictures, and expository discourse). Although the differences were not statistically significant, different performance patterns were observed across the discourse tasks. Examination of the participants' performance in the current study suggested a pattern in which participants performed best in expository discourse, followed by storytelling, and then sequential picture descriptions. Because expository discourse is a relatively novel task that has not been examined in prior studies, this pattern is difficult to compare directly with existing literature. However, interestingly, the observed pattern is inconsistent with findings from most previous studies comparing storytelling and sequential picture description tasks at the microlinguistic level. For example, Jozipović and colleagues (2025) sought to examine micro-level features using AphasiaBank protocols for eliciting discourse production across narrative (i.e., story retelling of *Cinderella*), expositional (i.e., sequential pictures), and procedural (i.e., participants explained how to make a peanut butter and jelly sandwich [PBJ]) discourse tasks. The study included 17 persons with mild to moderate aphasia and 17 healthy controls, and all participants were native Croatian speakers. Micro-level features were analyzed using lexical errors and lexical diversity (Moving-Average Type-Token Ratio [MATTR]). The authors reported that participants with aphasia produced more lexical errors in storytelling without pictorial support, the picture-supported procedural task (PBJ), and sequential picture description. This pattern differs from the present findings, in which micro-level errors were more frequent in the sequential picture description task than in the storytelling task. No significant differences in lexical diversity were found across different discourse types. Fergadiotis & Wright (2011) also investigated lexical diversity in mild to moderate aphasia. The participants demonstrated greater lexical diversity with sequential pictures when compared to single picture tasks, and similar levels of lexical diversity between storytelling and sequential picture tasks. In another study, Deng et al. (2024) explored discourse production across different discourse tasks in Mandarin-speaking individuals with anomic aphasia (n = 31) and healthy controls (n = 31). The authors utilized the Mandarin AphasiaBank protocol, which consisted of a single picture, sequential picture, story retelling, and procedural discourse (i.e., participants explained how to make ham and egg fried rice). Micro-level features were analyzed using total CIUs, CIUs/min, %CIUs, and words per minute (WPM). Notably, the participants with anomic aphasia produced the most informative discourse (i.e., %CIUs and CIUs/min) with the sequential picture task when compared to single pictures and storytelling at the micro-linguistic level. The authors concluded that sequential pictures may provide participants with more causal and temporal insights, resulting in more informative discourse.

At the macro-level, there were statistically significant differences in discourse production between expository and storytelling tasks, and between sequential picture and storytelling tasks. The current study's participants performed better in this order: storytelling, sequential pictures, and expository discourse. This pattern appears to contrast somewhat with the findings reported by Wójcik-Topór et al. (2026). The authors investigated cohesion and coherence across discourse tasks in 20 Polish-speakers with mixed aphasia and 10 healthy controls. They used a description of experiences related to their disorder, description of an important life event, sequential pictures, single pictures, retelling the *Cinderella* story, and procedural discourse task (i.e., participants explained how to make a ham and tomato sandwich). Cohesion was analyzed with procedures outlined by Halliday & Hasan (1976) (i.e., references, substitutions, ellipses, conjunctions, repetitions, and collocations). Global and local coherence was analyzed using a scale adapted for Polish speakers from Van Leer & Turkstra (1999). The authors found that individuals with aphasia performed better at the macro-level (i.e., produced higher cohesion scores) in spontaneous discourse tasks (i.e., explain history of disorder and describe a good or bad day) when compared to storytelling and procedural discourse (i.e., explain how to make a ham and tomato sandwich). Similar to the expository discourse task used in the current study, spontaneous discourse tasks do not include pictorial support. However, despite this shared characteristic, these tasks differ in their underlying cognitive and linguistic demands. Specifically, spontaneous and expository discourse tasks were found to engage distinct memory systems and processing mechanisms. In the spontaneous task used by Wójcik-Topór and colleagues, participants may have demonstrated better performance compared to storytelling tasks, whereas in the current study, participants performed better in storytelling than in expository discourse. One possible explanation for this discrepancy lies in the role of memory. Spontaneous discourse tasks often involve personally significant or emotionally salient experiences, such as describing the history of one's disorder. These events are more likely to be strongly encoded, easily retrieved, and frequently rehearsed through repeated retelling (Conway & Pleydell-Pearce, 2000; Rubin, 2006). In contrast, expository discourse tasks are typically less personally relevant and require speakers to generate and organize abstract content, such as forming claims and supporting arguments on topics like healthcare or homeschooling. These tasks rely less on direct experiential recall and more on the construction and organization of information, placing greater demands on semantic memory and executive processes (Binder & Desai, 2011; Baddeley, 2003). More broadly, spontaneous narrative and expository discourse differ in their memory bases. Personal narratives primarily draw on episodic-autobiographical memory, which provides rich, self-relevant content and well-established retrieval cues (Conway & Pleydell-Pearce, 2000). Expository discourse relies more heavily on semantic memory and the active assembly of information, which must be maintained and manipulated within working memory (Baddeley, 2003). Because emotionally significant personal experiences tend to produce stronger and more accessible memory traces, speakers may perform better on narrative tasks than on more abstract expository tasks that lack direct personal encoding (Rubin, 2006).

Overall, the findings of the current study are not fully aligned with prior research at either the micro- or macrolinguistic levels. As noted previously, differences in discourse tasks and outcome measures may partially account for these discrepancies, along with variations in target populations across studies. In particular, the participants in the current study presented with relatively mild language impairment, which may have influenced performance patterns. Possibly, the participants with mild aphasia may have performed better at the micro-level when pictures were not available because they were less restricted and had greater freedom to speak and develop their narratives. Also, the participants may have made more errors when pictorial support was not available because they had to manage and organize their utterance without the guidance that pictures provide. Lastly, the small sample size (n = 15) may also be a contributing factor, especially when considering the initial ANOVA showed statistical significance, whereas post hoc analyses did not reveal significant differences across tasks.

Cognitive relationships

The current study found significant relationships between discourse production and cognitive performance on several linguistic and non-linguistic tasks that tap into working memory, cognitive flexibility, and attention. At the micro-level, correlations were found with working memory, cognitive flexibility and attention. At the macro-level, correlations were found with cognitive flexibility and attention. Although this study has focused on mild aphasia specifically, these results provide empirical support for the broader theoretical consensus that discourse production requires the engagement of multiple cognitive domains (Dutta et al., 2024; Coelho, 2002; Lindsey et al., 2018; Marini et al., 2011). Because statistically significant correlations were found only for working memory, cognitive flexibility, and attention, the following results sections focus primarily on those findings.

Working memory. Individuals with better performance in Digit Span Backward produced fewer micro-level errors in storytelling and expository tasks. Impairments in working memory may contribute to difficulties in micro-level discourse production. Although only a limited number of studies have directly examined the relationship between working memory and discourse production in aphasia (e.g., Zahn, 2024), the present finding is broadly consistent with the literature indicating that working memory supports spoken language abilities in aphasia (see Salis et al., 2015, for a review), including studies of sentence-level production (e.g., Sung et al., 2018; Hartsuiker & Barkhuysen, 2007). Moreover, this result is consistent with theoretical accounts of discourse production. For example, within the framework proposed by Marini and colleagues (2023), working memory is involved in processes such as lexical selection, lemma activation, and lexical access. From this perspective, the present findings provide empirical support for the theoretical claim that working memory plays an important role in the micro-level aspects of discourse production. Additionally, it is noteworthy that the association between working memory and discourse production in the present study was observed only at the micro-level and not at the macro-level. This pattern was somewhat unexpected, particularly given the interdependence between micro- and macro-level discourse performance (Andreetta et al., 2012; Wright & Capilouto, 2012). It is also not fully consistent with the findings of Cahana-Amitay and Jenkins (2018), who reported an effect of working memory on macro-level discourse performance (i.e., local and global coherence) but not on micro-level performance. One possible explanation for this discrepancy may lie in the nature of the working memory measures used across studies. Cahana-Amitay and Jenkins (2018) employed word and sentence span tasks, which are more strongly tied to linguistic processing, whereas the present study used digit-based tasks. Digit span tasks are often considered to rely heavily on phonological processing (Jacquemot & Scott, 2006), which may make them more sensitive to the phonological working memory demands associated with micro-level discourse processes. This may help explain why working memory in the present study was associated specifically with micro-level discourse production rather than macro-level discourse organization.

Cognitive flexibility. Individuals with better performance on the Generative Naming task produced fewer micro-level errors in storytelling, expository discourse and sequential picture tasks, and faster completion of the OTMT produced fewer micro-level errors in storytelling and expository discourse tasks. Likewise, individuals with better performance on the Generative Naming task produced fewer macro-level errors in storytelling, and faster completion of the OTMT produced fewer macro-level errors in storytelling and sequential picture tasks. This is consistent with similar work by Dutta et al. (2024), who investigated the relationships between executive functions and discourse production in 22 individuals with mild to severe aphasia. To measure cognitive flexibility, the authors utilized the RFTT, the TVCF-CF, TVCF-LN, TVCF-Trails C, and the NIHTB-DDCS. Discourse production was elicited with storytelling given a picture book. Similar to the current study, the authors utilized multilevel linguistic analysis to examine errors in discourse at the micro- and macro-levels. Results demonstrated correlations between cognitive flexibility (i.e., TVCF-CF, TVCF-Trails C, RFTT, and NIHTB-DCCS) and micro-level features (e.g., speech rate, MLU, verbs per utterance, total CIUs, %CIUs and CIU/min). The authors also found correlations between cognitive flexibility (i.e., TVCF-CF, TVCF-LN, NIHTB-DCCS) and macro-level features (e.g., main concepts, organization, and local coherence errors). These findings imply the important role that cognitive flexibility plays at the micro-level (e.g., producing meaningful and informative messages) and at the macro-level (e.g., maintaining an organized, coherent narrative). Overall, cognitive flexibility likely supports not only the retrieval of relevant words, but also the organization and flow of discourse as a whole. Importantly, the current study extends these earlier findings by examining multiple discourse tasks both with and without pictorial support. Taken together, the results further suggest that cognitive flexibility is a fundamental cognitive component of discourse production, regardless of discourse type.

Attention. At the micro-level, individuals with better performance on the TEA-VE tasks (time and raw scores) produced fewer errors in storytelling, expository discourse, and sequential picture tasks. This indicates that better performance on attention measures could indicate faster and more accurate lexical retrieval and syntactic skills. At the macro-level, individuals with better performance on the TEA-VE tasks, as reflected in scores rather than times, produced fewer errors in storytelling and sequential picture tasks. This suggests that better performance on attention measures is associated with more consistent discourse organization skills. These findings support the theoretical framework that non-linguistic cognitive deficits impact language production in persons with aphasia (Fucetola et al., 2009; Murray, 2012; Villard & Kiran, 2016) and are consistent with prior studies. For example, Murray et al. (1998) investigated discourse production in 14 individuals with mild fluent aphasia and eight healthy controls using a picture description task with and without a secondary tone-discrimination task (dual task). The authors found that the mild fluent aphasia group with greater deficits in divided attention demonstrated more difficulty with the syntactic, lexical, and pragmatic aspects of discourse production. Later, Murray (2012) examined attention and its relationship to language abilities in 39 adults with aphasia and 39 healthy controls using the TEA, RUFF and the RSAB. The author did not incorporate discourse measures, opting to measure language capabilities with the ADP and the ASHA-FACS. They reported associations between performance on attention measures and overall communication and language abilities (as measured by the ADP and ASHA FACS) in persons with aphasia. Additionally, because the TEA-VE is self-paced, its timing score is typically interpreted as an index of switching efficiency once switching has been carried out correctly, whereas its accuracy score reflects the reliability of executing set shifts without losing the sequence (Bate et al., 2001). Within this framework, better TEA-VE performance may account for fewer micro-level breakdowns by indicating more effective attentional control to support lexical retrieval and syntactic formulation during discourse production. At the macro-level, only TEA-VE accuracy, and not timing, was associated with fewer errors in storytelling and sequential picture discourse. This finding suggests that the successful maintenance of a global discourse plan may depend more on consistent and reliable switching than on switching speed itself.

<u>Strengths and limitations</u>

To my knowledge, this is the first study focusing specifically on both linguistic and non-linguistic cognition and discourse production in mild aphasia. Given the remote administration of testing, data collection was not only constricted to one location (i.e., Florida), thus, the results could be more representative of a wider demographic. While previous studies have often examined linguistic cognitive scores, non-linguistic cognitive scores remain overlooked. The present study included both linguistic and non-linguistic cognitive scores. While the aforementioned are notable strengths, the study was also limited in several regards. As mentioned earlier, the study was conducted online to enable the recruitment of individuals with mild aphasia specifically. The online modality restricted the selection of cognitive measures, which required remote administration. Furthermore, some of the selected nonlinguistic measures still involved linguistic components; for instance, Digit Span tasks are not entirely free of linguistic demands. It is also important to note that participants had a range of comfort and familiarity with technology; thus, technology-fatigue could have also negatively impacted cognitive performance. Methodologically, micro- and macro-level errors were identified in the discourse samples, but the analysis focused on overall performance at the micro- and macro-levels rather than on individual error types, such as repetitions or semantic paraphasias. As a result, these findings do not indicate which specific types of errors at either the micro- or macro-level may be associated with particular cognitive components. Lastly, the small sample size (n =15) is not large enough to adequately represent the mild aphasia population. In particular, because the sample consisted primarily of well-educated participants (mean = 17.1 years) and White males (n = 11), future research should include larger and more diverse samples.

Conclusions and future directions

These findings suggest that individuals with mild aphasia produce fewer macro-level errors with storytelling tasks when compared to expository and sequential picture tasks. Possibly, the expository and sequential picture tasks place a higher level of demand on cognitive-linguistic function than storytelling tasks. Clinically, it is important to consider the impact of more cognitive-linguistic demanding discourse tasks (i.e., expository discourse and sequential pictures) used for obtaining language samples from individuals with mild aphasia, as performance may fluctuate based on the task selection.

Regarding cognitive relationships, linguistic and non-linguistic cognition impacts discourse production at the micro- and macro-levels in individuals with mild aphasia. My findings suggest that cognition influences not only lexical retrieval but also higher-level processes such as monitoring prior utterances and planning subsequent discourse. By targeting aspects of cognition such as working memory, cognitive flexibility, and attention, it may be possible to improve communicative function by reducing multilevel linguistic errors in discourse production. For example, the findings of the present study suggest that interventions targeting working memory may help improve micro-level performance, such as lexical retrieval, whereas interventions targeting cognitive flexibility and attention may support both micro- and macro-level performance, such as organizing utterances during storytelling.

Future research should further examine how discourse performance is affected by task type, as well as how specific linguistic and non-linguistic cognitive domains contribute to discourse production in individuals with mild aphasia. Particular attention should be given to the inclusion of nonlinguistic measures with minimal linguistic demands, and additional work with larger samples is needed to determine whether these relationships vary across aphasia types. Such efforts may help refine individualized treatment planning by identifying cognitive processes most strongly associated with specific discourse deficits. It is also worth noting that the association between cognition and discourse production was not found for expository discourse in this study. Given that expository discourse is still a relatively understudied task in this area of research, further investigation is warranted.

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Appendices

Appendix A: IRB approval

UNIVERSITY of SOUTH FLORIDA

APPROVAL

February 3, 2023

Hana Kim
4202 E Fowler Ave, PCD1017
Tampa, FL 33620

Dear Dr. Hana Kim:

On 2/3/2023, the IRB reviewed and approved the following protocol:

Application Type:	Initial Study
IRB ID:	STUDY005068
Review Type:	Expedited 6 and 7
Title:	Discourse and Cognition in Adults with and without Brain Injury
Funding:	Communication Sciences and Disorders
IND, IDE, or HDE:	None
Approved Protocol and Consent(s)/Assent(s):	• Study005068-Protocol-Brain-Injury-revised-1-2023.revised.docx; • Study005068-Consent-form-revised-1-2023.pdf; Approved study documents can be found under the 'Documents' tab in the main study workspace. Use the stamped consent found under the 'Last Finalized' column under the 'Documents' tab.

Within 30 days of the anniversary date of study approval, confirm your research is ongoing by clicking Confirm Ongoing Research in BullsIRB, or if your research is complete, submit a study closure request in BullsIRB by clicking Create Modification/CR.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

Bhupinder Sran
IRB Research Compliance Administrator

Institutional Review Boards / Research Integrity & Compliance
FWA No. 00001669
University of South Florida / 3702 Spectrum Blvd., Suite 165 / Tampa, FL 33612 / 813-974-5638
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