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Speech Pause in People With Aphasia Across Word Length, Frequency, and Syntactic Category

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ABSTRACT

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This study is an examination of how a word's syntactic category, word length, and usage frequency might impact a speaker's use of communicative pause. Previously collected between and within utterance language samples from 21 people with aphasia (Harmon, 2018) were evaluated in this study. Participants consisted of 11 individuals diagnosed with mild or very mild aphasia and 10 individuals with moderate aphasia;15 who exhibited fluent subtypes and 6 non-fluent subtypes of aphasia. Data from the Corpus of Contemporary American English (COCA) was used to code the word frequency and syntactic category of each word in the language samples. Generally, speakers with both non-fluent and fluent aphasia produced more monosyllabic words of very high frequency with a greater percentage of function words than content words. Analyses revealed no significant correlations between the pause duration for either the word length or word frequency for either group of speakers. In relation to syntactic category, no significant differences in pause duration were found between content and function words in the between utterance condition. However, non-fluent speakers preceded content words with significantly shorter pause durations within utterances when compared with the function words. Due to differences in sample sizes between the speaker and syntactic groups, non-parametric statistics were used for some comparisons. In addition, this study does not fully account for the influence of fillers and incomplete words. Despite these limitations, this study will contribute to the research regarding communicative speech pause in speakers with aphasia and provide insight into more useful diagnostic and treatment strategies.

Keywords: aphasia, pause, syntax, linguistic complexity, word length, word frequency

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DESCRIPTION OF THESIS STRUCTURE AND CONTENT

This thesis, *Speech Pause in People With Aphasia Across Word Length, Frequency, and Syntactic Category,* is part of a larger study exploring the impact of pause on speech communication in people with aphasia. Portions of this thesis may be submitted for publication, with the thesis author being included in the list of contributing coauthors. An annotated bibliography is provided in the Appendix.

Introduction

Spoken communication involves more than just words and sentences to convey linguistic and emotional information to a listener. It requires the prosodic elements of intonation, rhythm, and stress as well as the expression of affect that make communication successful. Pause is an additional component that contributes to the prosody and expression of speech. Pause plays an important role in speech's complex timing pattern and rhythm, providing information about the meaning and structure of an utterance (Zellner, 1994). Pause also adds emotional emphasis, an essential part of effective communication. The motoric, communicative, and linguistic functions of pausing have been a topic of interest for researchers of both typical and clinical populations for many years. As a result, the study of pause in spontaneous speech has provided useful information regarding speech and language for a wide variety of disciplines (Kirsner et al., 2002). Clearly, pause is an important part of spoken communication worthy of close examination.

Typical Use of Speech Pause

Ordinary discourse is filled with pauses of various durations. Even the most "verbally competent" adults produce speech that contain strings of words which are frequently separated by pauses (Goldman-Eisler, 1956). The motoric functions of pausing can be as simple as the beginning or end of a respiratory cycle or a hesitation in the shift of articulatory movements needed to produce speech (Rose, 2017). A typical use of speech pause may also be to indicate verbal planning (Goldman-Eisler, 1964) or to anticipate a sudden increase of information (Goldman-Eisler, 1961).

The presence or absence of pause within an utterance can be further influenced by the style of speech being used by the speaker (Maclay & Osgood, 1959). Public speakers, politicians,

and actors often use communicative pause for emphasis or the art of "timing" to create the intended effect on their audience. This use of pause is planned and practiced so that the resulting speech is relatively fluent, in contrast to spontaneous speech that is more likely to include speech pauses reflecting the individual's cognitive processing of verbal planning and word selection (Goldman-Eisler, 1964; Rochester, 1973). Speech pause is also used by speakers to signal a conversational turn (Walker, 1982) and to intentionally emphasize or persuade (Heike et al., 1983).

Speech pause is also used by typical speakers to support linguistic functions within a message such as grammatical functions, semantic focus, or hesitations (Zellner, 1994). Speakers use pause to systematically mark syntactic boundaries (Hammen & Yorkston, 1994). For example, during spontaneous speech typical speakers pause at locations related to "cognitive strides" (Henderson et al., 1966). In other words, pauses give the speaker time to organize and structure what they are about to say (Angelopoulou et al., 2018; Goldman-Eisler, 1968). In addition, speech pause can increase the intelligibility of an utterance by allowing the listener more time to process the content expressed by the speaker (Whitfield & Goberman, 2017).

Overall speaking time consists of speaking (or articulation) time and pause time. While articulatory movement rates are generally constant on an individual basis, pause time is more variable (Goldman-Eisler, 1961). A study by Goldman-Eisler (1961) found that on average approximately 40-50% of a typical speaker's utterance time is occupied by pauses. According to Klatt (1976), pauses may occur in 30% of prose reading and as much as 50% of the spontaneous speech in people without disability.

Pause can be categorized into two types: the silent pause, an absence of sound; and the filled pause, a one-syllable sound or word such as "um," "uh," or "well" used to fill in gaps of

speech content (Dollaghan & Campbell, 1992). Both types of pauses are used in the everyday speech of typical speakers. Maclay and Osgood (1959) suggested that the use of a filled pause as opposed to a silent pause may signal the speaker's attempt to maintain control of a conversation by indicating they are not finished speaking. In a study by Goldman-Eisler (1968), 99% of the silent pauses produced by adults during spontaneous speech were shorter than two seconds, and Brotherton (1979) found that 75% of silent pauses produced during the spontaneous speech of adults were less than one second in length. The longer the pause, the more dramatic the effect on the listener. The standard duration for pauses to be more easily perceived is around 200 – 250 ms (Goldman-Eisler, 1968; Grosjean & Deschamps, 1975).

In general, tasks that require greater cognitive load or require the speaker to perform a more complex task than reading or reciting a prepared script (such as spontaneous speech) can result in longer pauses (Rochester, 1973). Pause can also indicate the transitional probabilities between words. For typical speakers, pauses generally occur most often before less frequent words and words with low contextual predictability (Beattie & Butterworth, 1979; Rochester, 1973). In contrast, pauses have been found to occur less often before words of higher predictability (Goldman-Eisler, 1958; Rochester, 1973).

As mentioned previously, pauses also contribute to the overall prosodic quality of speech. Pauses help create the timing parameters that make up the rhythmic patterns of speech (Zellner, 1994), provide emotional emphasis, as well as detection of punctation (Levy et al., 2012). Thus, pause can play an important role in the meaning of an utterance, thereby increasing intelligibility.

Atypical Use of Speech Pause

In contrast, when pause is used atypically during speech, intelligibility is reduced (Reich, 1980; Yorkston et al., 2010). One reason for this is that typical pause is often used to mark

syntactic boundaries between phrases or sentences. During typical speech, pauses are generally used by the speaker and listener to organize a message by chunking utterances into meaningful units (Yorkston et al., 2010). This "chunking" of information is important for the intelligibility of the speaker's message. In addition, listeners often use pause to assign syntactic structure to a speaker's utterance before decoding the rest of the information (Weismer, 1990, as cited in Chapey, 2008). Thus, when pauses are produced in nongrammatical locations, listeners have more difficulty categorizing the parts of speech in an utterance (Reich, 1980). Listener perceptions of an individual's speech can also be influenced by the use of pause. According to a study by Price (2021), atypical pauses can negatively impact a listener's perception of the speaker's personality and psychological attributes, confidence, willingness to help, as well as competence and likability.

Atypical Use of Speech Pause in People With Aphasia

It is rare to encounter a perfectly articulate speaker during spontaneous speech. In both typical and atypical speech, attempts to correct or modify a previous utterance are common. However, the presence of searching behaviors, such as the use of pauses of longer duration, can be indicative of impaired language processing (Dollaghan & Campbell, 1992; Schlenck et al., 1987).

Individuals with acquired neurogenic language impairment, commonly known as aphasia, produce longer pause durations during their speech compared to neurotypical speakers (Angelopoulou et al., 2018). This difference may be indicative of lexical retrieval, processing speed, or language planning difficulties (DeDe & Salis, 2020). Increased processing demands or cognitive load may also influence the frequency and duration of pauses in the speech of this population (DeDe & Salis, 2020). The use of pause plays a critical role in communication

disorders, both in research and in practice (Kirsner et al., 2002). Although formal classification of aphasia type requires some subjectivity on the part of the clinician, the use of pause in speech plays a role in identifying aphasia as fluent or non-fluent (Goodglass et al., 1964). While individuals with aphasia often have some form of word-finding difficulty, those with non-fluent types of aphasia typically present with greater frequency and longer durations of pause during speech compared to other aphasia types (Danly & Shapiro, 1982; Price, 2021).

In a study exploring the different patterns of pause duration distributions in the speech of individuals with aphasia compared to neurotypical speakers, Angelopoulou et al. (2018) found that both groups produced both short and long pauses, however the median of long pauses for the aphasic group was significantly higher. They also found that individuals with aphasia produce shorter pauses before nouns and noun phrases and longer pauses before verbs. This pattern was found to be similar in the neurotypical control group. However, the increased frequency and duration of long pauses in the aphasic group was indicative of communicative impairment. It was also discovered that the aphasic group produced more long pauses within utterances than between.

Long pause rate is also inversely associated with mean length of utterance (MLU), suggesting an impairment in sentence planning (Angelopoulou et al., 2018). A low MLU may also be indicative of decreased sentence complexity in individuals with both fluent and non-fluent types of aphasia.

Marking Syntactic Category

Morphology can be defined as the set of rules that govern how words are formed and their relationship to other words (Chapey, 2008). Impaired morphology and syntax are common in the speech of individuals with aphasia. The degree to which language is impaired depends

largely on the site of lesion and aphasia type. For example, individuals diagnosed with Wernicke's aphasia have impaired language comprehension as well as deficits in lexical semantics (e.g., production of neologisms and semantic paraphasias), however, syntax remains relatively intact. In contrast, individuals diagnosed with Broca's aphasia are able to understand language more easily but have a significantly impaired ability to produce speech, often limited to two or three-word utterances, thus greatly impacting syntactic structure. These utterances are reduced to the most minimal information-carrying words of the speaker's message, often lacking articles, prepositions, pronouns, and other function words that form a speech pattern known as "agrammatism" (Gleason et al., 1975). It has been suggested that agrammatic production, as well as certain sentence comprehension difficulties in people with aphasia, originates from a deficit in morpho-syntactic working memory (Matchin & Rogalsky, 2017). In individuals with Conduction aphasia, semantics and syntax are relatively intact, but repetition and phonological processing are significantly impaired (Matchin & Rogalsky, 2017).

Although similarities in language abilities can be seen among individuals with the same aphasia diagnosis, it is important to note that there is significant individual variability among patients with relatively similar areas of brain damage (Matchin & Rogalsky, 2017). For example, some patients with fluent types of aphasia are able to correctly produce a variety of simple syntactic forms. However, their use of complex syntactic forms is limited compared to their neurotypically healthy peers (Chapey, 2008). This results in sentences containing simple and/or incomplete syntactic structures (Bird & Franklin, 1996; Cappa et al., 2000; Edwards & Bastiaanse, 1998). This may be evident in their use of articles, prepositions, conjunctions, and personal pronouns that signal relations between parts of a sentence. Individuals with aphasia also

frequently misuse or omit morphologic inflections such as possessive /-s/, plural /-s/, or present progressive /-ing/ (Chapey, 2008).

To better understand the syntactic structures of utterances produced by people with aphasia, researchers typically assign a syntactic category to each word. One method for determining the syntactic category of words is to divide them into content and function words. Content words include nouns, verbs, adjectives, and some adverbs. All other parts of speech, such as pronouns, prepositions, and conjunctions are considered function words (Bird et al., 2002). In discourse, function words provide complex phrasing or sentence structure that connect the story elements together (Kim et al., 2021).

Researchers also use syntactic category to better understand deficits in word retrieval. Word retrieval is another common problem for individuals with aphasia. Content words in the discourse of this population are typically examined to provide greater insight to this impairment (Kim et al., 2021). Although less common, studies regarding function words in the discourse of people with aphasia have also been beneficial, including function word use as identifiers of different subtypes of aphasia (Saffran et al., 1989). For example, Saffran and colleagues (1989) found that participants with agrammatic aphasia produced significantly less function words in discourse compared to the non-agrammatism aphasia group. Correlations between function word production and severity of aphasia have also been found (Kim et al., 2021).

Examining the presence or absence of content and function word use in people with aphasia during discourse provides clinicians with useful diagnostic information as well as possible treatment strategies in a less time-consuming way. Research examining a possible relationship between length of pause and content versus function words in this population is limited. Thus, a closer examination of any potential correlations would be of interest.

Word Length

The type and severity of aphasia has a direct impact on an individual's ability to produce utterances of increasing linguistic complexity or word length. For non-fluent types of aphasia, MLU is significantly reduced due to effortful and halting speech, but low MLU in the speech of individuals with fluent types of aphasia can also indicate reduced sentence complexity (Angelopoulou et al., 2018). This can include an increased use of monosyllabic words versus multisyllabic words in order to reduce linguistic complexity, such as word length. Fluency breakdowns, including pauses, are also more likely to occur before longer words of high complexity that require more time for planning compared to shorter words of reduced complexity (Anderson, 2007). Pause durations are also affected by word length (Kirsner et al., 2002).

Word length in utterances produced by people with aphasia may also be influenced by co-occurring diagnoses that often accompany aphasia such as apraxia of speech or dysarthria. Apraxia of speech is characterized by impaired motor planning and/or programming, which negatively impacts the individual's ability to access previously learned motor sequences to produce speech. Individuals with apraxia of speech have particular difficulty with more complex articulatory movements, such as producing multisyllabic words. Dysarthria is a neuromuscular impairment that often results in muscular weakness and can affect any or all of the subsystems for speech, thus directly impacting the individual's ability to execute speech movements.

Word Frequency

Word frequency is the statistical probability of a word occurring in a given language. Words have traditionally been divided into high and low-frequency words, and word frequency has been shown to play an important role in the accuracy and speed of lexical access (Akbari,

2016). Repeated exposure to a word allows an individual to develop greater familiarity with the word, thus improving lexical access to that word. Therefore, lexical access of low-frequency words takes longer than high-frequency words (Akbari, 2016). In addition, studies indicate that high-frequency words are produced with greater fluency than words of lower frequency (Chapey, 2008; Griffin & Bock, 1998). This seems to hold true for both neurotypical speakers as well as people with aphasia. For example, a study by Beattie and Butterworth (1979) found a relationship between the use of pause in individuals with aphasia and contextual predictability and word frequency. Content words of low contextual predictability were used less often than other words, and both contextual predictability and word frequency were associated with the presence of pause in speech. Function words were not examined in this study; therefore, it would be useful to examine their relationship with the use of pause in speech as well.

It is important to note that word frequency for an individual is determined by their unique experiences, needs, occupation, culture, and many other factors (Chapey, 2008). This should be taken into consideration when looking at correlations between pause duration and word frequency.

Study Purpose

Additional research on speech pause in people with aphasia may provide clinicians with a better understanding of a speaker's language production difficulties, thus providing better starting points for improved intervention planning. Although previous studies have identified relationships between aphasia and the use of pause, there is currently limited information about how atypical pauses in aphasia influence and are influenced by word length, word frequency, and syntactic category. Thus, the purpose of this study is to explore the following questions:

1. Do extended speech pauses produced by people with aphasia differ according to word length (monosyllabic vs. multisyllabic)?
2. Do extended pauses produced by people with aphasia differ according to word frequency (high, mid, low tier)?
3. In people with aphasia, do extended pauses in speech differ in terms of length and frequency according to syntactic category?

Methods

Speech Recordings

The speech recordings analyzed in this study were collected in a previous project by Harmon (2018), which examined communication from people with aphasia in terms of listener attitudes, attention, and emotion. The current study utilized speech samples collected from 21 speakers with differing types and severity of aphasia. Eleven of the participants were diagnosed with mild or very mild aphasia and 10 individuals with moderate aphasia as measured by scores on the Western Aphasia Battery Aphasia Quotient (WAB-AQ). Eight participants identified as male and 13 as female. The average age of the participants was 59 years (ranging from 32 to 81 years). All of the speakers except one had completed some college with an average of 16 years of education within the group. Nineteen participants acquired aphasia as a result of a stroke, one individual acquired aphasia from a traumatic brain injury, and one individual from lesions caused by Multiple Sclerosis. Please see Table 1 for specific demographic information of participants.

Speech samples were collected by asking participants to complete a narrative discourse task. Each participant was presented with auditory and visual stimuli (i.e., a voice recording and pictures of a story). Subjects practiced the narrative discourse one time with the investigator before recording the language sample. Each sample was approximately one to two minutes in

Table 1

Demographic Information for Participants With Aphasia

Subject	Gender	Age	WAB-AQ	Aphasia Type	Aphasia Subtype	Aphasia Severity	Apraxia Severity	Dysarthria Severity
01	Female	58	87.0	Fluent	Anomic	Mild	21	8.0
02	Female	56	90.7	Fluent	Anomic	Mild	39	11.0
03	Female	81	92.7	Fluent	Anomic	Mild	39	8.5
04	Male	33	87.6	Fluent	Anomic	Mild	44	10.5
06	Female	48	77.8	Nonfluent	Transcortical Motor	Moderate	50	12.5
08	Male	56	100.0	Fluent	Latent	Very Mild	48	12.5
09	Female	59	89.9	Fluent	Anomic	Mild	47	13.0
10	Female	72	72.2	Nonfluent	Broca's	Moderate	32	9.0
11	Female	65	84.3	Fluent	Anomic	Mild	44	10.0
12	Female	61	74.1	Fluent	Anomic	Moderate	27	10.5
13	Female	61	67.5	Nonfluent	Broca's	Moderate	32	10.0
14	Male	61	67.0	Fluent	Wernicke's	Moderate	42	13.0
16	Male	60	95.4	Fluent	Latent	Very Mild	49	12.0
17	Female	72	82.8	Fluent	Anomic	Mild	29	9.5
18	Female	71	94.0	Fluent	Latent	Very Mild	50	13.0
19	Male	72	97.4	Fluent	Latent	Very Mild	41	12.0
20	Male	60	75.0	Fluent	Anomic	Moderate	43	13.0
21	Female	32	63.7	Fluent	Conduction	Moderate	34	10.0
22	Female	56	52.1	Nonfluent	Broca's	Moderate	43	11.0
23	Male	64	72.7	Nonfluent	Broca's	Moderate	35	8.5
24	Male	48	68.2	Nonfluent	Broca's	Moderate	45	11.0

Note. Data collected and apraxia/dysarthria severity calculated by Harmon, 2018. Lower dysarthria and oral apraxia ratings indicate greater presence of dysarthria or apraxia respectively.

length. A consent agreement approved by the Institutional Review Board at UNC-Chapel Hill was signed by each participant (IRB Study #16-2544).

Coding of the Pause Data

The dependent measures of length of pause for the speech recordings described above were completed in a previous project by Thomas (2021). This study extended this analysis by coding each word in the language sample immediately following the measured pause lengths in terms of three additional independent variables: (a) word length, (b) word frequency, and (c) syntactic category.

Word Length

A transcript of each of the speech recordings was transposed into an excel spreadsheet reporting each word into a separate cell, as shown in Figure 1. The morphological complexity of a word was determined by counting the number of syllables for words at the beginning and within utterances.

Word Frequency

The frequency within the English language for each word in the speech recordings was determined by using the Corpus of Contemporary American English (COCA; Davies, 2008-2022). The COCA contains more than one billion words of text, including more than 25 million words for each year from 1990-2019. The text is evenly divided between eight genres: spoken, fiction, popular magazines, newspapers, academic texts, TV and movies subtitles, blogs, and other web pages, allowing for a corpus that is truly representative of contemporary English (Davies, 2008-2022). Approximately 25% of the corpus is drawn from spoken language, both scripted and unscripted conversations. Each word was entered into the database, from which a frequency ratio, ranking, and tiering (very high, high, mid, or low) was coded for each word. The addition of a very high frequency tier was made to account for the large discrepancy between the highest and

lowest ranked words in the high category. This allowed for a discrimination between high frequency words that are used on a regular basis and those used less often but still within the high frequency category. Considering the limited standards in the literature defining divisions in word frequency and the circumstance that only a portion of the COCA database contains samples drawn from spoken language, for purposes of this study the following guidelines were created to determine frequency tiers. Words in the COCA ranked 1 – 200 with an approximate frequency of 470,000 or more per 1 billion words were considered part of the very high frequency tier. Words ranked 201 – 2,000 with an approximate frequency of 45,000 to 469, 999 per 1 billion words were considered in the high frequency tier, while words ranked 2,001 – 5,000 with an approximate frequency of 12,000 to 44, 999 per 1 billion words were categorized in the mid frequency tier. Finally, words ranked 5,001+ with an approximate frequency of 11,999 or less per 1 billion words were included in the low frequency tier.

Syntactic Category

A transcript of each of the speech recordings was transposed into an excel spreadsheet dividing each word into a separate cell. Each word was then coded as either a content or function word. Nouns, verbs, adjectives, and adverbs were coded as "content" words, while pronouns, prepositions, and conjunctions were coded as "function" words. The presence of a phrase or sentential boundary was previously determined by a project conducted by Harmon et al. [Unpublished manuscript]. This was done by separating the utterances into C-Units, defined as an independent clause with its modifiers. An independent clause is a statement containing both a subject or noun phrase and a predicate or verb phrase.

Statistical Analysis

Descriptive statistics were used to report the pause duration mean and standard deviations produced by speakers for both between utterance and within utterance sentence locations. The incidence rate for each word in the speech recordings as a function of syllable length, frequency tier, and syntactic category were also listed. It is important to note that the pause before the first utterance of each subject sample was not analyzed since these pauses were just the beginning of the recording and were therefore unable to be measured accurately. The descriptive statistics concerning communicative pause length for the "within" utterance data did not include any pause lengths prior to the beginning of an utterance as this would be considered "between" pause data. We also did not calculate the frequency data for pauses before incomplete words or filled segments.

Relationships between speech pause patterns and differing word length and word frequency were examined using Pearson Correlations. Considering that the independent variable of syntactic category includes nominal data from more than two groups with differing sample sizes, differences in pause duration were examined using a Kruskal-Wallis non-parametric test. The significance of post-hoc pairwise comparisons were adjusted using a Bonferroni correction for multiple comparisons.

To simplify the inferential analysis of the syntactic categories, the word tokens were grouped into "content" and "function" categories. Content words were nouns, verbs, contractions, adjectives, adverbs, and proper nouns. Function words included pronouns, prepositions, conjunctions, articles, determiners, numbers, and negations. Word tokens were determined using the COCA database. Differences across these two categories were examined using an Analysis of Variance when the sample sizes of the two groups were approximately

equal, thereby preserving the assumption of equal variance. However, if the sample sizes between the levels of a variable were notably different, non-parametric tests were used (Mann-Whitney U).

Results

Non-Fluent Aphasia Subtypes

Descriptive statistics of pause durations produced by speakers with non-fluent aphasia for both between utterance and within utterance sentence locations are listed in Table 2. This table also includes the incidence rate for each word in the speech recordings as a function of syllable length, frequency tier, and syntactic category.

Word Length

As shown in Figure 1, the majority of words at the beginning of an utterance (immediately following a between utterance pause) were monosyllabic (93%), with a very small percentage of bisyllabic words (5.17%), and even fewer trisyllabic words (1.72%). Within utterances, the non-fluent speakers with aphasia also produced more monosyllabic words (88.9%), compared to bisyllabic (10%) and trisyllabic word types (0.97%), as illustrated in Figure 2.

The measures of pause duration either between or within utterances did not significantly correlate to the number of syllables in the following word for the recordings of the non-fluent speakers with aphasia.

Word Frequency

The data revealed that at the beginning of an utterance (between utterances), participants with non-fluent aphasia produced mostly very high frequency tier words (88%), followed by

Figure 1

Percentage of Syllable Length Between Utterances for Non-Fluent Participants

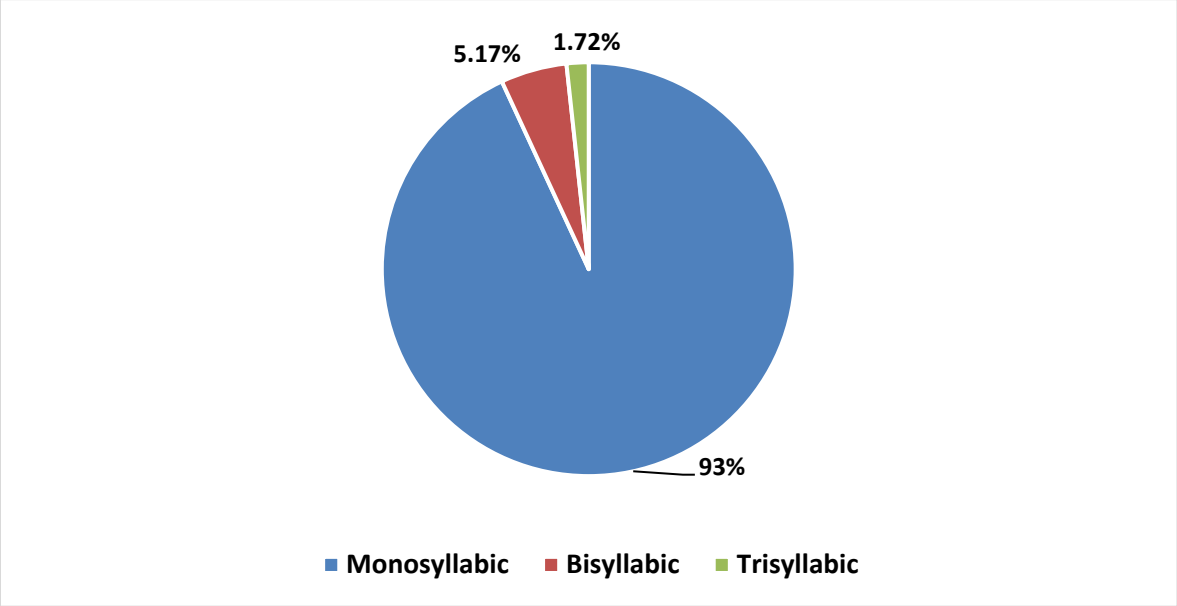
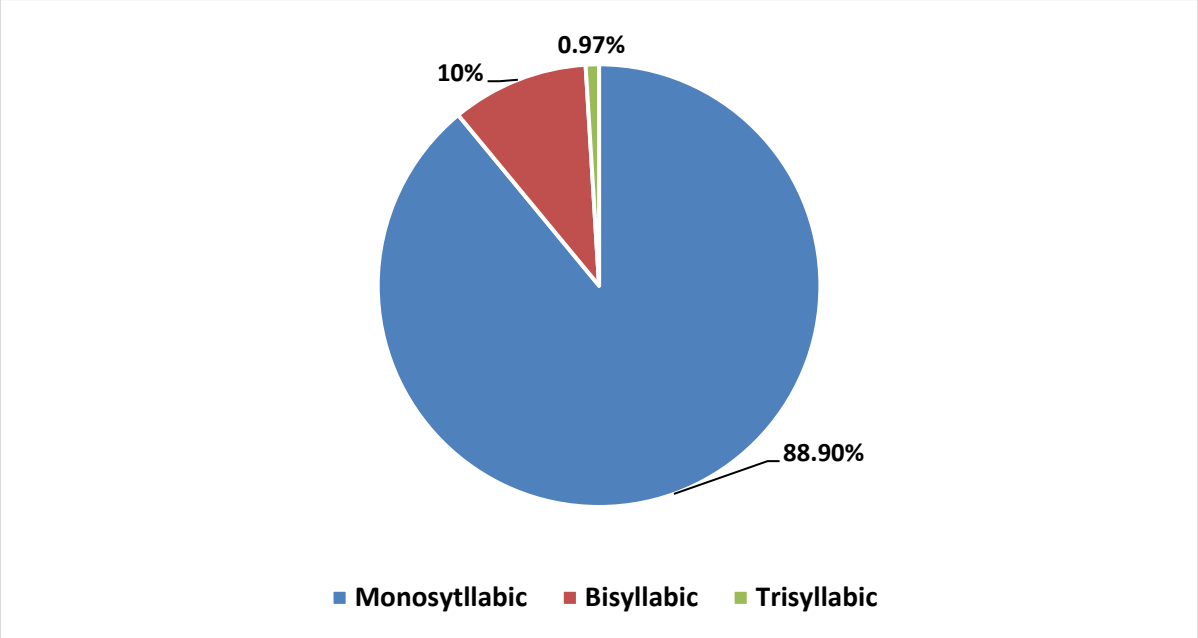


Figure 2

Percentage of Syllable Length Within Utterances for Non-Fluent Participants



high (8.62%), and low frequency words (3.45%) as displayed in Figure 3. Interestingly, of the non-fluent utterances collected in this study none were categorized as mid frequency words. For the within utterance words, Figure 4 illustrates that (71.16%) were classified in the very high tier, (22.46%) as high, (5.44%) as mid, and (1.65%) as low frequency tiered words.

Inferential tests of Pearson Correlations found no significant relationship between the pause prior to an utterance or within an utterance to the frequency of the following word.

Syntactic Category

In this study, the majority of words used by non-fluent speakers to begin an utterance were function words (74%), with fewer content words (26%). As shown in Figure 5, most of the function words are classified as conjunctions (50%), followed by pronouns (16%). For words produced within an utterance, about 35% were content words and the remainder were found to be function words. Approximately 14% of the words within utterances were verbs, 11%

Figure 3

Percentage of Frequency Tiers Between Utterances for Non-Fluent Participants

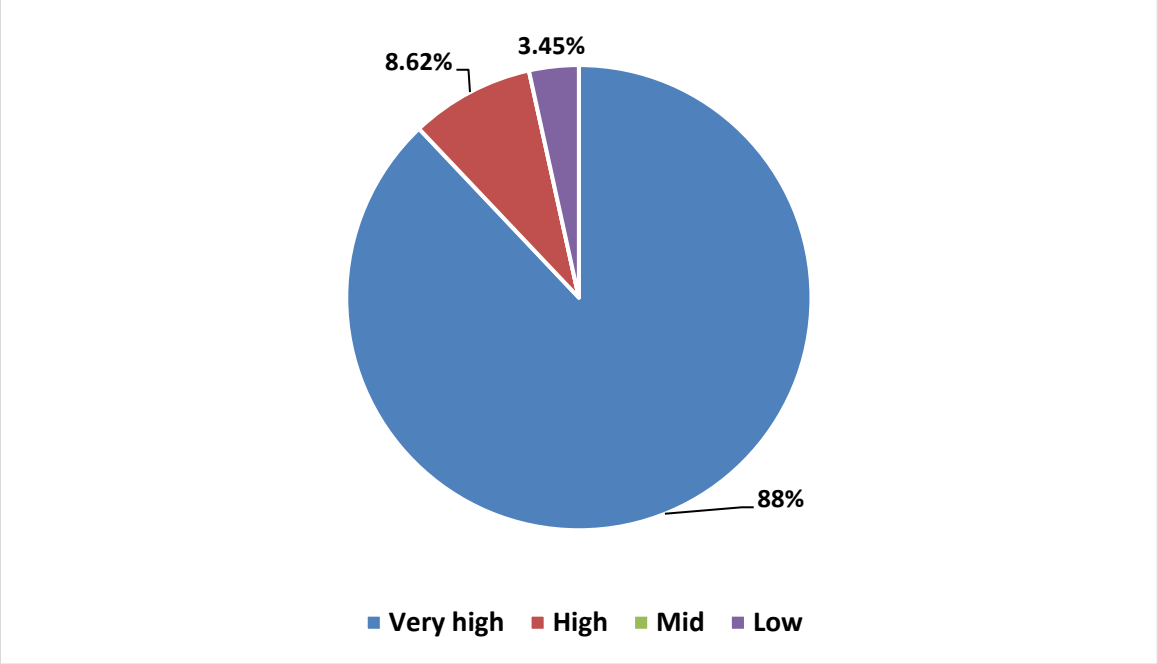


Figure 4

Percentage of Frequency Tiers Within Utterances for Non-Fluent Participants

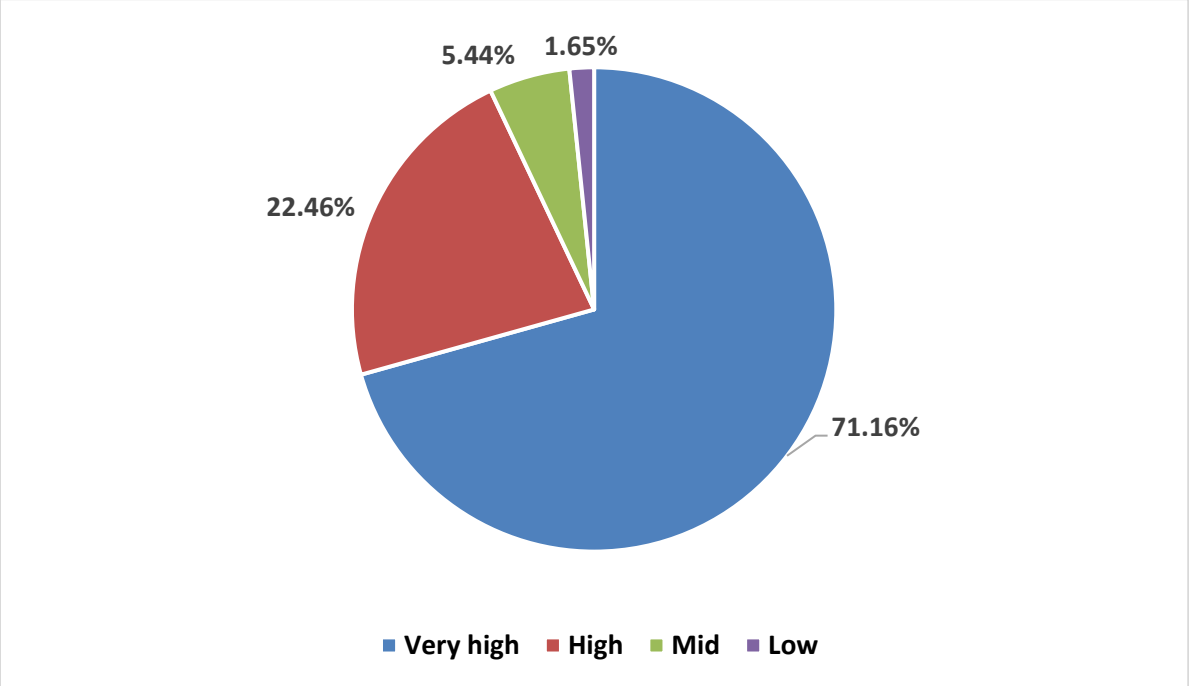


Figure 5

Percentage of Syntactic Category Between Utterances for Non-Fluent Participants

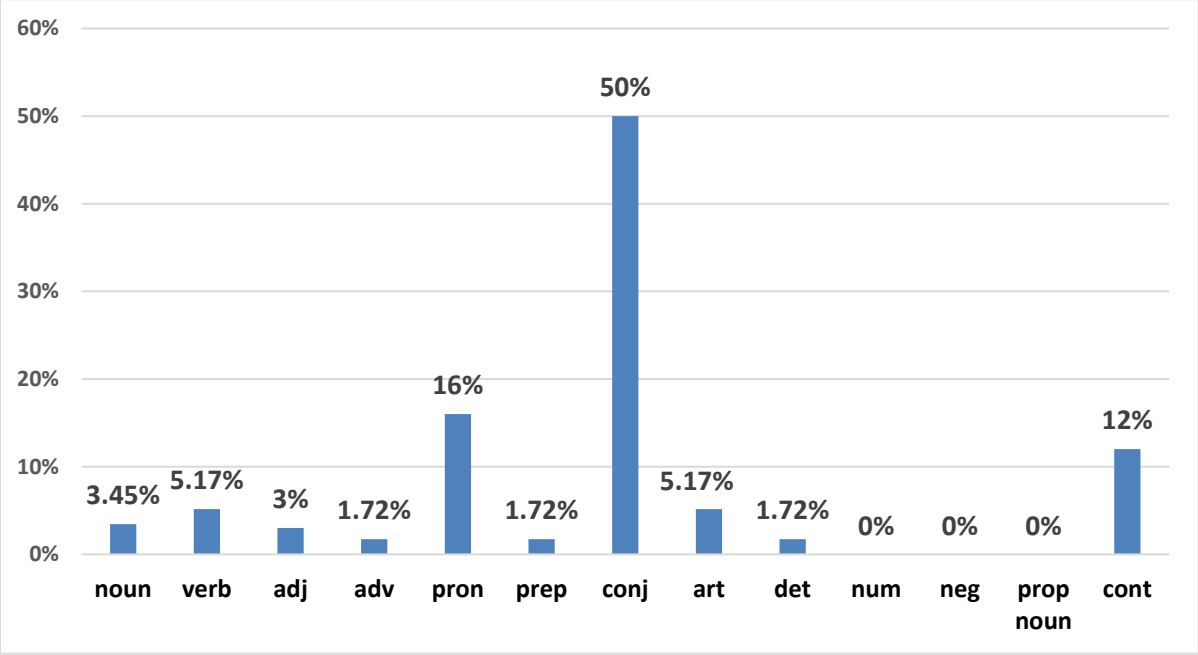
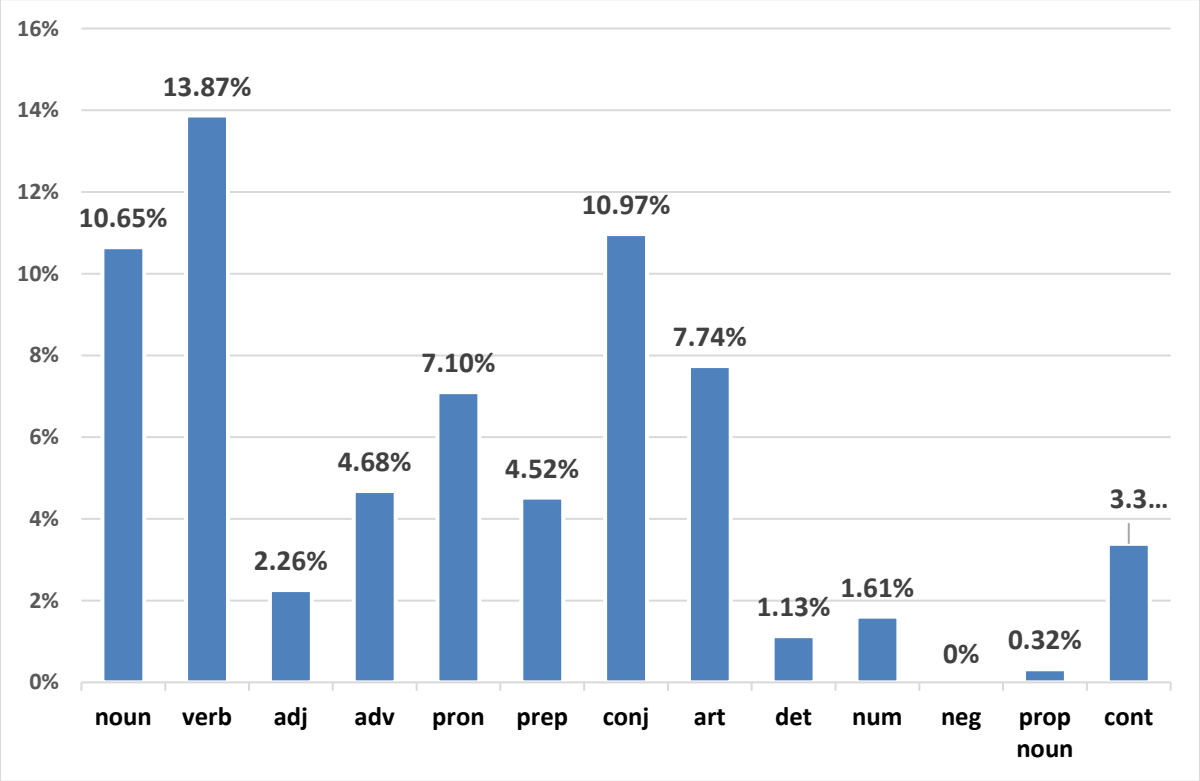


Figure 6

Percentage of Syntactic Category Within Utterances for Non-Fluent Participants



conjunctions, 11% nouns, 8% articles, and 7% pronouns as seen in figure 6 below. As previously mentioned, a detailed incidence for each syntactic category of words at the beginning and within utterances can be found in Table 2.

Considering that the syntactic category data is an independent nominal variable composed of more than two levels with somewhat differing sample sizes, a non-parametric Kruskal-Wallis test of significance was used to examine possible differences in the pause durations. Due to a limited number of tokens produced for some syntactic categories (<10) only the conjunctions, pronouns, and contraction word types were examined in the between utterance condition whereas all the syntactic categories were evaluated for the within utterance condition. Significance values were adjusted by the Bonferroni correction for multiple tests.

Table 2

Incidence and Pause Duration Measures Across Syllable Length, Frequency Tier, and Syntactic Category for Non-Fluent Aphasic Speakers

Measure	Subtype	Between Utterances			Within Utterances		
		Incidence	Pause[b]		Incidence	Pause[b]	
		%	Mean	*SD*	%	Mean	*SD*
Word Length	Monosyllabic	93.0	2.577	3.76	88.9	0.934	2.02
	Bisyllabic	5.2	6.095	2.17	10.0	0.684	1.22
	Trisyllabic	1.7	0.389	-	1.0	0.809	0.63
	Terasyllabic	-	-	-	-	-	-
Frequency Tier	Very High	88.0	2.221	3.02	71.2	0.766	1.32
	High	8.6	7.033	7.53	22.5	0.542	1.15
	Mid	-	-	-	5.4	0.585	0.82
	Low	3.5	4.52	0.79	1.7	1.345	2.89
Part of Speech[a]	Noun	3.5	5.553	0.67	10.7	0.399	0.89
	Verb	5.2	7.284	10.28	13.9	0.426	0.86
	Adjective	3.0	6.129	3.06	2.3	1.471	2.30
	Adverb	1.7	0.389	-	4.7	0.191	0.37
	Pronoun	16.0	5.108	4.82	7.1	0.929	1.39
	Preposition	1.7	0.988	-	4.5	0.747	1.24
	Conjunction	50.0	1.484	2.08	11.0	0.919	0.82
	Article	5.2	3.863	3.06	7.7	0.995	1.66
	Determiner	1.7	0.673	-	1.1	0.886	0.62
	Number	-	-	-	1.6	1.489	3.22
	Negation	-	-	-	-	-	-
	Proper Noun	-	-	-	0.3	0.629	0.89
	Contraction	12.0	1.270	1.70	3.4	0.794	1.58

Note. [a]The syntactic categories were combined into content (Nouns, Proper Nouns, Verbs, Adjectives, Adverbs) and function categories (pronoun, prepositions, conjunctions, articles, determiners, numbers, negations, contractions) in subsequent analyses. [b]Measured in seconds.

The Kruskal-Wallis test showed a significant difference in the pause duration across syntactic categories evaluated in the between utterance condition, $H(2) = 6.931$, $p = .031$. Pairwise comparisons found that the pause durations before pronouns were significantly higher ($p<.01$) than for conjunctions and contractions. For the within utterance condition, pause duration differences between the syntactic word types (all categories) were significant, $H(11) = 35.439$, $p< .001$. After applying the Bonferroni correction, the only significant pairwise differences were between the conjunction word types with longer pause durations compared with the adverbs ($p = .03$) and nouns ($p = .005$).

Using a non-parametric test (Mann-Whitney U), no significant differences in pause duration were found between the content and function words in the between utterance condition. However, for pause durations within utterances, an ANOVA found that the non-fluent speakers preceded content words with significantly shorter durations (494 ms) when compared with the function words (942 ms), $F(1) = 13.519$, $p < .001$.

Fluent Aphasia Subtypes

Descriptive statistics of the pause duration means and standard deviations produced by speakers with fluent aphasia for both between utterance and within utterance sentence locations is listed in Table 3. This table also includes the incidence rate for each word in the speech recordings as a function of syllable length, frequency tier, and syntactic category.

Word Length

As shown in Figure 7, the majority of words produced at the beginning of an utterance (immediately following a between utterance pause) were monosyllabic (96%) in nature, compared to a much smaller percentage of bisyllabic words (1.36%) and slightly greater number of trisyllabic words (2.71%).

Table 3

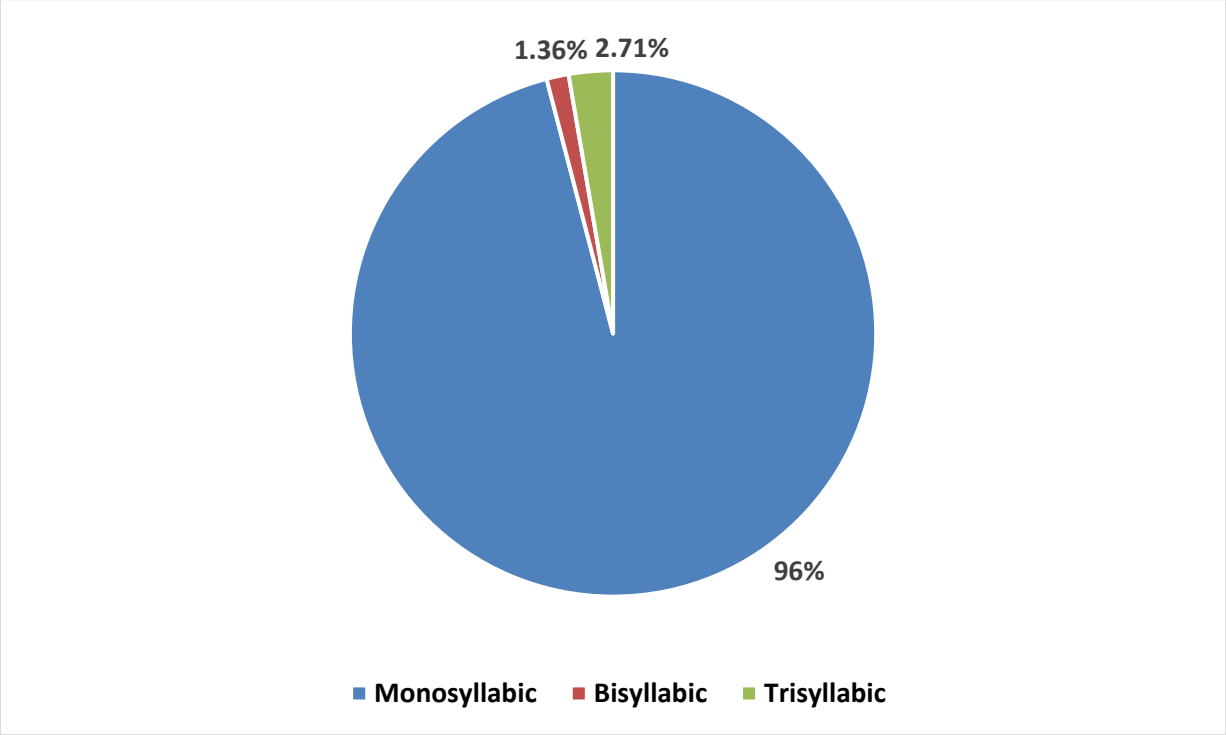
Incidence and Pause Duration Measures Across Syllable Length, Frequency Tier, and Syntactic Category for Fluent Aphasic Speakers

Measure	Subtype	Between Utterances			Within Utterances		
		Incidence	Pause[b]		Incidence	Pause[b]	
		%	Mean	*SD*	%	Mean	*SD*
Word Length	Monosyllabic	96.0	0.807	0.77	84.7	0.322	0.65
	Bisyllabic	1.4	4.988	7.05	12.6	0.266	0.91
	Trisyllabic	2.7	1.093	0.69	2.4	0.221	0.40
	Terasyllabic	-	-	-	0.1	0.190	0.27
Frequency Tier	Very High	94.1	0.806	0.78	59.7	0.301	0.65
	High	4.1	2.414	4.05	18.7	0.234	0.76
	Mid	1.4	1.063	0.13	5.8	0.298	0.76
	Low	0.5	0.123	-	15.8	0.457	0.68
Part of Speech[a]	Noun	0.5	0.123	-	12.5	0.168	0.47
	Verb	0.9	0.427	0.60	17.9	0.159	0.45
	Adjective	-	-	-	1.9	0.195	0.62
	Adverb	5.9	1.855	3.43	7.9	0.304	1.02
	Pronoun	10.4	1.201	1.33	11.7	0.297	0.69
	Preposition	-	-	-	5.0	0.232	0.63
	Conjunction	75.0	0.765	0.67	11.2	0.532	0.75
	Article	3.2	1.102	0.79	11.0	0.318	0.76
	Determiner	0.5	1.183	-	1.8	0.281	0.44
	Number	-	-	-	1.4	0.294	0.46
	Negation	-	-	-	0.1	0.598	0.36
	Proper Noun	1.4	0.967	0.10	1.3	0.548	0.82
	Contraction	2.7	0.314	0.24	2.5	0.229	0.42

Note. [a]The syntactic categories were combined into content (Nouns, Proper Nouns, Verbs, Adjectives, Adverbs) and function categories (pronoun, prepositions, conjunctions, articles, determiners, numbers, negations, contractions) in subsequent analyses. [b]Measured in seconds.

Figure 7

Percentage of Syllable Length Between Utterances for Fluent Participants



Within utterances, fluent speakers with aphasia produced more monosyllabic words (84.71%), compared to bisyllabic (12.64%) and trisyllabic words (2.39%), as illustrated in Figure 8.

The measures of pause duration either between or within utterances did not significantly correlate to the number of syllables in the following word for the recordings of the participants with fluent aphasia.

Word Frequency

For fluent speakers with aphasia, the data revealed that at the beginning of an utterance (between utterances), mostly very high frequency tier words were produced (94.12%), followed by high (4.07%), mid (1.36%), and very few low frequency words (0.45%) as displayed in Figure 9. For the within utterance words, Figure 10 illustrates that 59.66% were classified as very high, 18.72% as high, 5.78% as mid, and 15.84% as low frequency tiered words. Once

Figure 8

Percentage of Syllable Length Within Utterances for Fluent Participants

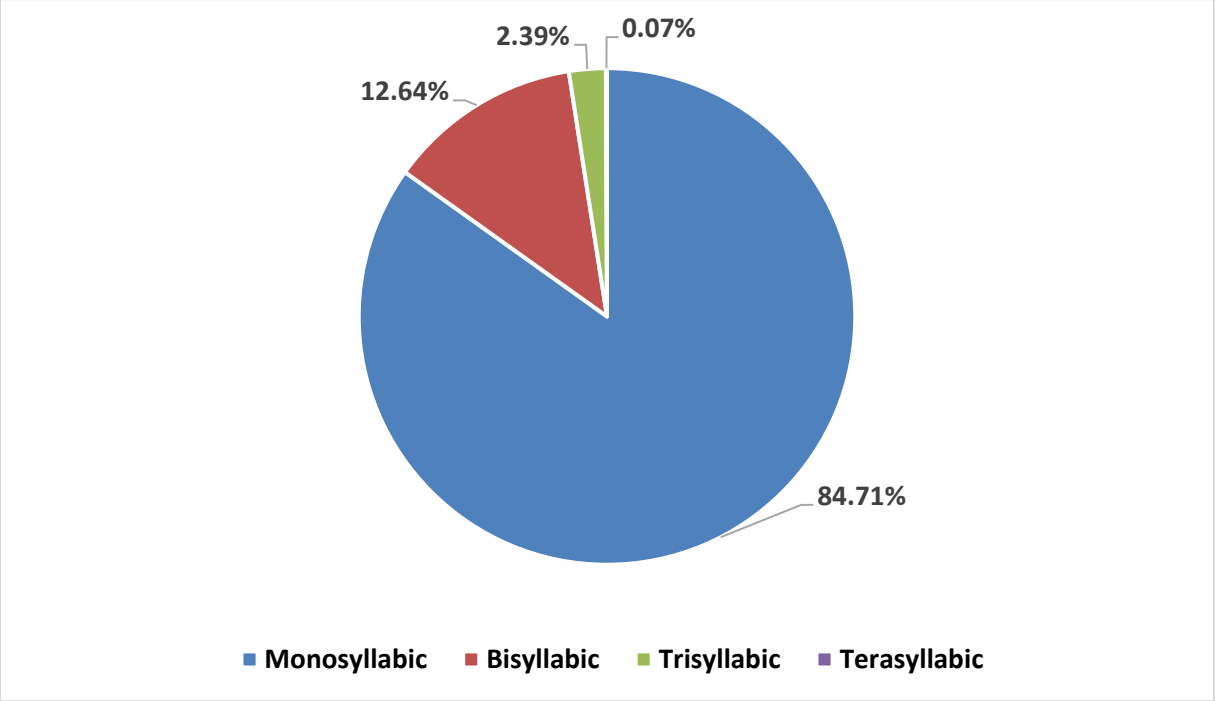


Figure 9

Percentage of Frequency Tiers Between Utterances for Fluent Participants

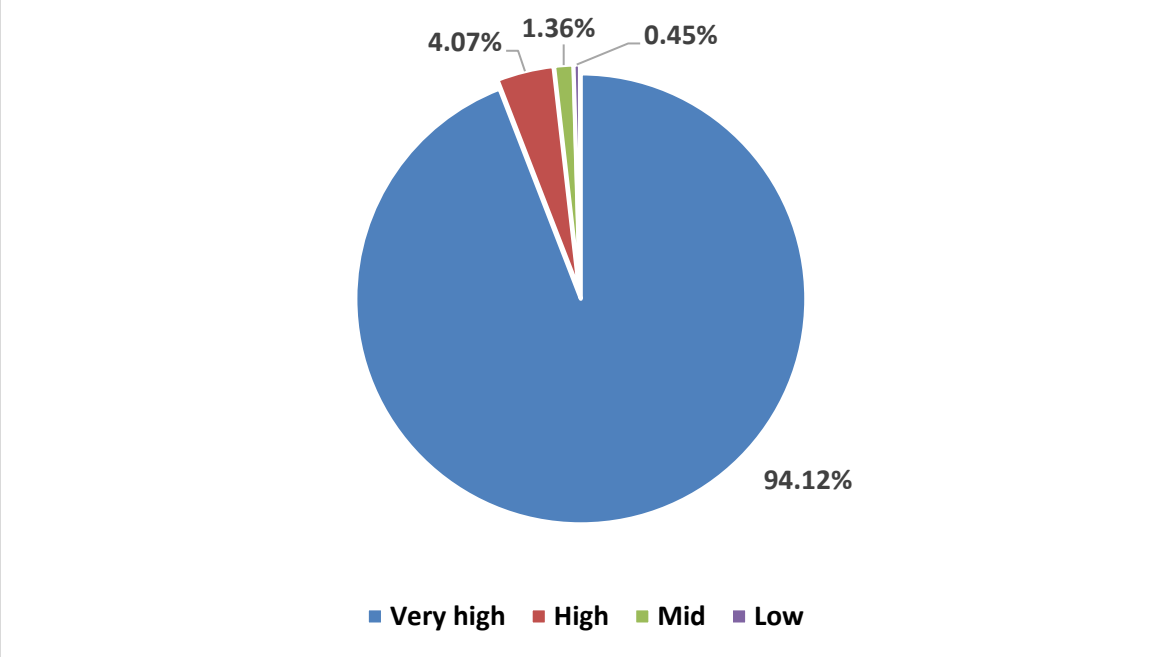
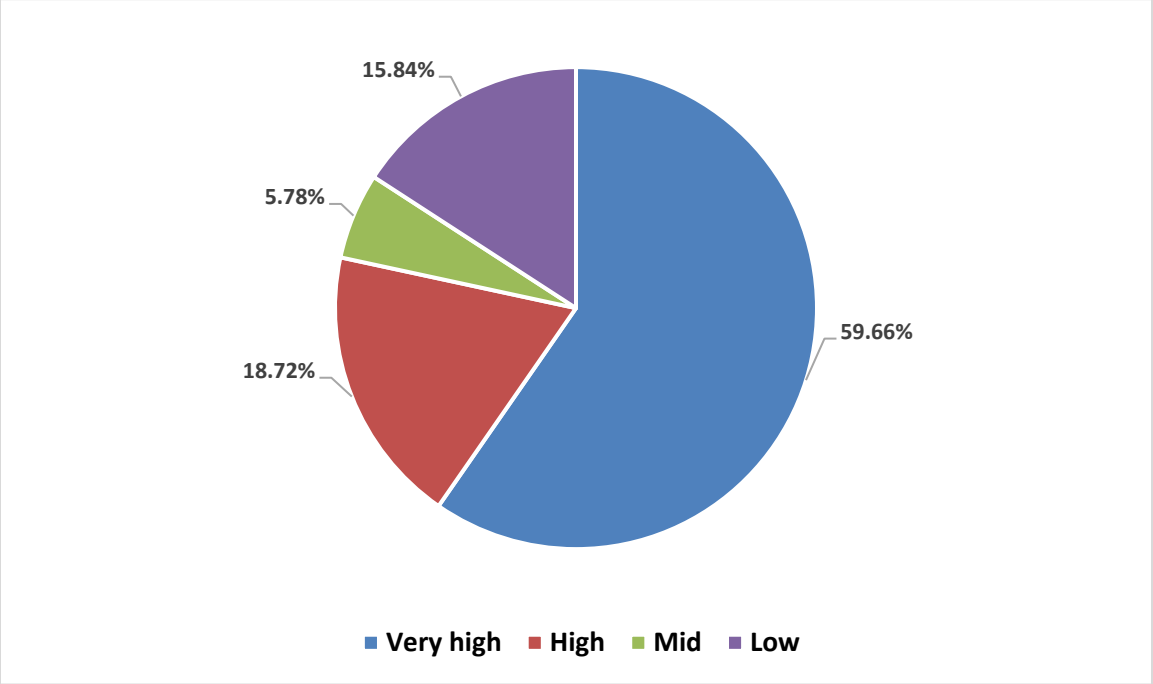


Figure 10

Percentage of Frequency Tiers Within Utterances for Fluent Participants



again, inferential tests of Pearson Correlations found no significant relationship between the pause prior to an utterance or within an utterance to the frequency of the following word.

Syntactic Category

The majority of words used by fluent speakers to begin an utterance were function words (89%), with very few content words (11%). As shown in Figure 11, most of the function words are classified as conjunctions (75%) followed by pronouns (10.4%) as the next most commonly used word type. For words produced within an utterance, 44% were content words and the remainder were function words. As shown in Figure 12, approximately 18% of the words within utterances were verbs, 13% nouns, 12% pronouns, 11% conjunctions, 11% articles, and 8% adverbs. Refer to Table 3 for a detailed incidence for each syntactic category of words at the beginning and within utterances.

Figure 11

Percentage of Syntactic Category Between Utterances for Fluent Participants

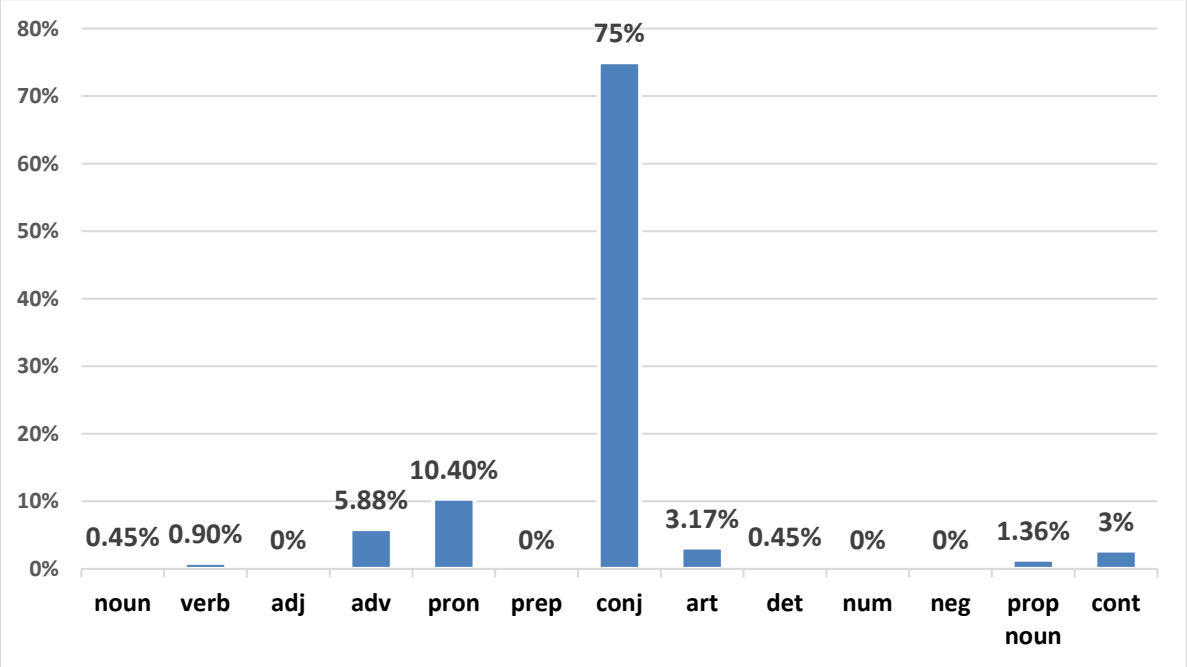
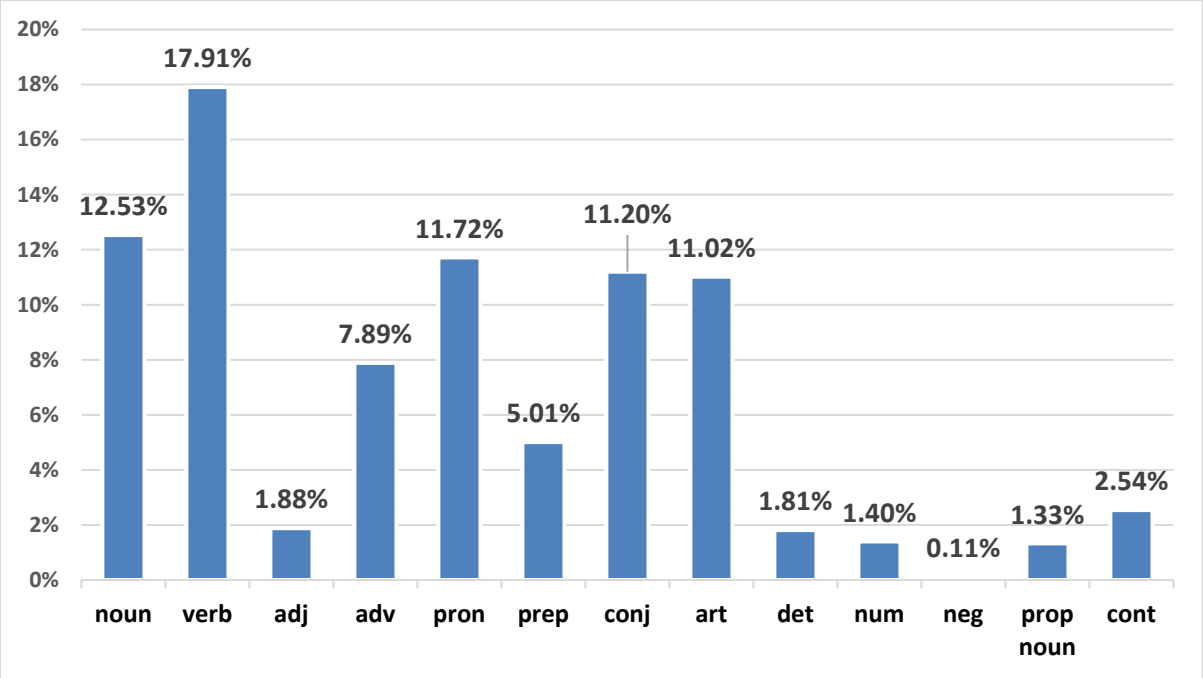


Figure 12

Percentage of Syntactic Category Within Utterances for Fluent Participants



Due to a limited number of tokens produced for some syntactic categories (<10) only the conjunctions, pronouns, and adverb word types were examined in the between utterance condition, whereas all the syntactic categories were evaluated for the within utterance condition. Significance values were adjusted by the Bonferroni correction for multiple tests. The Kruskal-Wallis test showed no significant difference in the pause duration across syntactic categories evaluated in the between utterance condition. For the within utterance condition, pause duration differences between the syntactic word types (all categories) were significant, $H(12) = 101.912$, $p < .001$. After applying the Bonferroni correction, the significant pairwise differences are listed in Table 4.

Using a non-parametric test (Mann-Whitney U), no significant differences in pause duration were found between the content and function words in the between utterance condition. However, for pause durations within utterances, an ANOVA found that the fluent speakers preceded content words with significantly shorter durations (204 ms) when compared with the function words (357 ms), $F(1) = 30.602$, $p < .001$.

Discussion

Previous work by Thomas (2021) measured and analyzed the pause durations of these language samples as a function of aphasia severity and subtype. The purpose of this study was to extend those findings by investigating the possible associations between pause durations produced by people with aphasia and the word length, word frequency, and syntactic category of their intended speech productions.

Table 4

Non-Parametric Statistics Following Bonferroni Correction for Within Utterance Pause Durations for Fluent Speakers

Pairwise Comparison	Test Statistic	Std. Error	Std. Test Statistic	Adj. Sig.[a]
verb-art	192.432	39.529	4.868	0.000
verb-num	343.267	89.678	3.828	0.010
verb-conj	345.691	51.662	6.691	0.000
verb-prop noun	538.250	95.771	5.620	0.000
adj-conj	-327.523	88.038	-3.720	0.016
adj-prop noun	-520.083	119.389	-4.356	0.001
noun-art	156.767	42.550	3.684	0.018
noun-conj	310.025	54.008	5.740	0.000
noun-prop noun	-502.584	97.057	-5.178	0.000
adv-conj	-263.221	59.470	-4.426	0.001
adv-prop noun	-455.780	100.198	-4.549	0.000
pron-conj	258.009	55.202	4.674	0.000
pron-prop noun	-450.569	97.726	-4.611	0.000
prep-conj	246.044	64.552	3.812	0.011
prep-prop noun	-438.604	103.296	-4.246	0.002

Note. [a]Bonferroni adjustment for multiple comparisons

Non-Fluent Aphasia

Word Length

For the participants with non-fluent aphasia, the majority of words produced in the language samples were monosyllabic, with very few bisyllabic or trisyllabic words. This held true for pauses between utterances and within utterances. These findings are consistent with the study by Angelopoulou et al. (2018) who found that individuals with aphasia demonstrate an increased use of monosyllabic versus multisyllabic words in discourse. As proposed by

Angelopoulou et al. (2018), this may be the result of an attempt to reduce the linguistic complexity of utterances by limiting their discourse to mostly single syllable words.

In contrast to a study by Anderson (2007) where longer pauses were more likely to occur before multisyllabic words, data from the current study did not show a significant correlation between pause duration for both between and within utterances and the number of syllables in the following word. This was unexpected since multisyllabic words are generally more difficult to produce and are not used as often as monosyllabic words by aphasic speakers. Further, considering that pause durations in the speech of neurotypical speakers are also known to be impacted by word length (Kirsner et al., 2002), it is surprising that the findings of this study did not follow a similar pattern. A possible explanation for this may be that more complex words are in fact preceded by longer pauses, but the speaker with aphasia employs the strategy of selecting a shorter word that is easier to produce thereby masking any association between significant pause and lingual complexity.

Word Frequency

Previous studies have shown that high frequency words are produced with greater incidence than lower frequency words in people with aphasia (Beattie & Butterworth, 1979). This is consistent with the findings from this study. The non-fluent individuals with aphasia produced more very high frequency words for both between and within utterances than any other words. Considering that both neurotypical speakers and individuals with aphasia have the most exposure to high frequency words and use them at a higher rate, it is reasonable that individuals with aphasia would continue to maintain a greater lexical access to these types of words than lower frequency words.

No significant relationship was found between the pause duration prior to a word that begins an utterance or within an utterance and the frequency of that particular word. It is difficult to determine why this would be since even neurotypical speakers have slower lexical access to lower frequency words (Akbari, 2016). We know that individuals with aphasia are not working with a typical processing system, and therefore perhaps not following typical patterns of production regarding word frequency. In addition, similar to the thoughts expressed regarding word length, the non-fluent aphasic speakers may be using both unintended and intended strategies to produce speech, thereby masking the impact of word frequency on pause duration. Although the production of high frequency words may be less difficult and result in shorter preceding pause times, when trying to produce a low frequency word, speakers may self-select an easier high frequency word instead. Unfortunately, it is not possible to determine the intended word, only the word that was produced.

Syntactic Category

In this study, the majority of words used by non-fluent speakers for between utterances were function words. This was an unexpected finding for non-fluent aphasic speakers whose utterances are often limited to only a few words and often lacking in function words, also known as agrammatism. Further, non-fluent individuals with aphasia have been known to employ the compensatory strategy of initiating their utterances with proper nouns or nouns (content words), whereas typical speakers begin their utterances with pronouns (function words; Gleason et al., 1975). A possible explanation for this difference may be the type of discourse the participants were being asked to produce. Narrative discourse requires the use of function words to connect story elements together, so the strategy of beginning each utterance with a function word such as “and” to move the story forward is logical. In fact, 50% of the words used to begin an utterance

were conjunctions. This may also be a type of resource-saving strategy employed by speakers with aphasia when they are having difficulty producing a word and so they use a familiar, simple word. In the case of this narrative discourse, this seems to be conjunctions. These conjunctions may also have been used as a type of "filled" pause that allowed for more cognitive processing time preceding the next utterance.

In contrast to the between utterance condition, non-fluent participants produced content and function words almost equally within utterances. Once again, this was surprising considering the nature of non-fluent aphasia and the general difficulty of producing more than two or three-word utterances at a time. Beginning an utterance with a conjunction like "and" or "so" is logical, but once the speaker is within the utterance it would be more typical of this subtype to produce mainly content words without regard to the syntax created by adding function words.

Although no significant differences in pause duration were found between the content and function words in the between utterance condition, content words had significantly lower pause durations than function words within utterances. Speakers with non-fluent aphasia such as Broca's aphasia are typically limited to content words in their speech (Chapey, 2008) and so it is not surprising that these words were produced with less hesitation than function words.

Fluent Aphasia Subtype

Word Length

Similar to the non-fluent participants, monosyllabic words were primarily used in the discourse of the fluent aphasia participants for both between utterances and within utterances. These findings are supported by previous research that has found that although individuals with fluent aphasia can typically produce simple syntactic forms in their utterances, their use of

complex syntactic forms is limited (Chapey, 2008), thereby accounting for the predominantly monosyllabic words in the narrative discourse samples.

Analyses did not reveal a significant relationship between pause duration and the number of syllables in the following word for either the between or within utterances productions. It is interesting that this result is similar to the non-fluent participants who typically have greater difficulty producing connected speech, however, the majority of monosyllabic words in the samples are rote in nature (conjunctions), making them almost mechanical or repetitious. This may account for the similar patterns in speech pause between the two groups of speakers.

Word Frequency

Similar to non-fluent aphasia subtypes, participants with fluent aphasia produced mostly very high frequency words at the beginning of an utterance (between utterances) and within utterances. However, they did produce a greater variety of words from other frequency tiers within utterances than between. This is to be expected as fluent subtypes of aphasia have easier lexical access for word production than non-fluent subtypes and generally produce a greater number of words per utterance.

Inferential statistical analyses did not reveal a significant relationship between the pause duration prior to an utterance or within an utterance to the frequency tier of the following word. As explained for similar results related to non-fluent speakers, this is an unexpected finding as neurotypical speakers have faster lexical access to higher frequency words than lower frequency words and it would be expected that this would affect the speed of production for both neurotypical speakers and those with non-fluent and fluent aphasia.

Syntactic Category

The majority of words produced by the fluent participants with aphasia to begin an utterance were function words with very few content words, whereas content words and function words were produced almost equally within utterances. An explanation for this increase in content words within utterances may be the ability of typical fluent speakers with aphasia to be able to produce simple syntactic utterances that include nouns and verbs. There are also more opportunities to produce words from various syntactic categories within utterances than at the beginning of utterances.

Using a Kruskal-Wallis non-parametric test and a Bonferroni adjustment for multiple comparisons, a number of significant differences in pause duration were found between the 12 different syntactic categories. However, to simplify the inferential analysis of the syntactic categories, the word tokens were grouped into “content” and “function” categories. No significant differences in pause duration were found between the content and function words in the between utterance condition. However, fluent speakers preceded content words with almost half the pause duration time within utterances when compared with the function words. This result seems logical considering that fluent aphasia subtypes are able to create sentences with simple syntax that include nouns and verbs. The addition of function words increases the complexity of the utterance and would therefore be more difficult to produce without hesitations.

Limitations and Future Research

There were a number of limitations involved in this study. First, language samples were collected from an unequal number of fluent and non-fluent speakers, with twice the number of fluent than non-fluent participants. These differences in sample size made it difficult to maintain the assumptions of equal variance between groups, thereby necessitating the use of non-

parametric statistical comparisons in some instances. Second, there may have been a mismatch between the spoken language samples used in this study and the COCA database used to measure a word's frequency. The COCA database draws only about 25% of its words from spoken language (scripted and unscripted). Although there are spoken language frequency corpora available, the COCA is one of the largest and most conveniently accessed frequency databases. Finally, this study does not account for filled pauses in a comprehensive manner. The independent variables in this study (word length, frequency, syntactic category) could only be applied to real words. It would be of interest to examine these same language samples with the aim of gaining a detailed understanding of the speakers' use of incomplete words and filled pauses. It may also be of interest to examine the relationship between extended pause in people with aphasia and changes in the prosodic contours of their speech. In addition, it may be of interest to examine possible differences in the use of pause between spontaneous elicitation of language and elicitation tasks that have an intended word target. This type of experimental design might provide insight into the intended (strategic) and unintended use of speech pause in people with aphasia.

Conclusions

Individuals with aphasia demonstrate a variety of language deficits that allow researchers to investigate specific grammatical structures that have become impaired. The presence and duration of pause while creating these grammatical structures can provide valuable information regarding which aspects of language create the most difficulty for the individual. Despite the limitations of this study, it provides additional research regarding the role of pause in identifying areas of impairment and therefore potential types of intervention, specifically in how pause relates to word length, word frequency, and syntactic category. Continued research can lead to

increased understanding of how linguistic and cognitive processes work together in the language production of individuals with aphasia.

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Rochester, S. (1973). The significance of pauses in spontaneous speech. *Journal of Psycholinguist Research 2*(1)**,** 51–81. https://doi.org/10.1007/BF01067111

Rose, R. (2017). Silent and filled pauses and speech planning in first and second language production. In R. Eklund (Ed.), *Proceedings of Disfluency in Spontaneous Speech* (pp. 49-52). Royal Institute of Technology (KTH).

Saffran, E. M., Berndt, R. S., & Schwartz, M. F. (1989). The quantitative analysis of agrammatic production: Procedure and data. *Brain and Language*, *37*(3), 440-479. https://doi.org/10.1016/0093-934x(89)90030-8

Schlenck, K. J., Huber, W., & Willmes, K. (1987). “Prepairs” and repairs: Different monitoring functions in aphasic language production. *Brain and Language*, *30*(2), 226-244. https://doi.org/10.1016/0093-934x(87)90100-3

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APPENDIX

Annotated Bibliography

Angelopoulou, G., Kasselimis, D., Makrydakis, G., Varkanitsa, M., Roussos, P., Goutsos, D., Evdokimidis, I, & Potagas, C. (2018). Silent pauses in aphasia. *Neuropsychologia, 114,* 41–49. https://doi.org/10.1016/j.neuropsychologia.2018.04.006

Objective: To explore the different patterns of pause duration distributions in the speech of individuals with aphasia (IWA) compared to typical speakers. *Method:* Participants included 18 individuals with chronic aphasia following a left hemisphere stroke and 19 healthy adults with matching age, gender, and level of education. Speech samples were collected and transcribed from both groups and silent pauses were annotated using ELAN. *Conclusions*: Both groups demonstrated short and long pauses in their speech, with the majority of short pauses before nouns and noun phrases and long pauses before verbs. The median of long pauses in IWA was significantly higher than the median for the control group. The individuals with aphasia produced more long pauses than short pauses within utterances than between utterances. Overall, they found that post-stroke aphasia does not affect the general pattern of pauses during speech, however it does increase pause rate and duration. *Relevance to current study:* Individuals with aphasia produce longer pauses in their speech than typical speakers. They produce more short pauses before nouns and noun phrases and more long pauses before verbs, similar to neurologically healthy speakers. However, the increased frequency and duration of long pauses is indicative of impairment. Long pause rate is also strongly and inversely associated with MLU, suggesting an impairment in sentence planning. They also produce more long pauses within utterances than between them. This article also cites several

studies suggesting that low MLU may be indicative of decreased sentence complexity in individuals with both fluent and non-fluent aphasias.

Beattie, G. W., & Butterworth, B. L. (1979). Contextual probability and word frequency as determinants of pauses and errors in spontaneous speech. *Language and Speech*, *22*(3), 201-211.https://doi.org/10.1177/002383097902200301

Objective: To investigate the relationship between pauses in spontaneous speech and the contextual probability and word frequency of the lexical items that follow. *Methods:* Participants included three native English speakers with a mean age of 24 and completion of at least an undergraduate degree. Samples were analyzed from 3 ½ hours of spontaneous discussions and transduced into a graphic representation of phonation and silence. The Cloze procedure was used to measure contextual probability by deleting every nth word and then asking judges to guess the deleted items. *Conclusion:* Both contextual probability and word frequency were associated with hesitations (pause) in speech. *Relevance to current study:* Pauses generally occur before less frequent words and words with low contextual probability. This may also hold true for individuals with aphasia.

Beeke, S., Wilkinson, R., & Maxim, J. (2009). Prosody as a compensatory strategy in the conversations of people with agrammatism. *Clinical Linguistics & Phonetics*, *23*(2), 133-155. https://doi.org/10.1080/02699200802602985

Objective: To analyze the use and function of intonational pitch variation in the agrammatical speech of individuals with aphasia. *Methods:* A detailed microanalysis is performed of how three British English speakers with varying severity of agrammatism use prosody, and how it is responded to by their conversational partners in the everyday

conversation of their home environment. Three video recordings of conversations were used that totaled about 20 minutes of talk. *Conclusions:* All three speakers produced a pattern of prosody characterized by level pitch or a minor pitch rise on non-final lexical items and ended turn-final lexical items with a falling/rising pitch movement. The study shows that people with agrammatism caused by aphasia retain their prosodic skills and use them to compensate for impaired grammar to manage turn taking in a conversation. *Relevance to current study:* Prosody can be used as a compensation strategy when grammar is disrupted in the speech of individuals with aphasia.

Danly, M., & Shapiro, B. (1982). Speech prosody in Broca's aphasia. *Brain and Language*, *16*(2), 171-190. https://doi.org/10.1016/0093-934X(82)90082-7

Objective: To describe the three aspects of speech prosody and assess whether it is normal or impaired, and to demonstrate how both the intact and disordered elements of prosody in this population can provide information to infer the planning of speech and linguistic structure in Broca's aphasia. *Method:* Five right-handed males with Broca's aphasia were asked to read 10 pairs of sentences, each with two key words in different positions to test possible phonetic influences on duration. Each subject was asked to read each sentence to himself, then produce the sentence verbally to be recorded. Measurements were recorded for the initial, middle, and final position of each key word. Unusual stress patterns were noted as well as durations of segments and silence. *Conclusions:* It was found that some aspects of prosody were spared and others were abnormal. All subjects, regardless of severity of impairment, exhibited a fall in sentence final fundamental frequency. Sentence final lengthening was absent. *Relevance to current*

study: While some prosodic elements may remain intact in individuals with Broca's aphasia, others may be impaired, especially those involved in producing complex syntax.

DeDe, G., & Salis, C. (2020). Temporal and episodic analyses of the story of Cinderella in latent aphasia. *American Journal of Speech-Language Pathology, 29*(1S), 449–462. https://doi.org/10.1044/2019_AJSLP-CAC48-18-0210

Objective: To examine the temporal and episodic organization of discourse produced by people with latent aphasia. *Method:* Praat was used to analyze the duration of speech segments, dysfluencies including pause, and other behaviors in narratives about Cinderella from 10 people with latent aphasia, 10 people with anomic aphasia, and 10 neurotypical controls. *Conclusions:* The latent and anomic aphasia groups had longer silent pause duration and slower speech rate than controls. *Relevance to current study:* People with aphasia produce longer pause durations in their speech compared to neurotypical speakers. This difference may be indicative of lexical retrieval, processing speed, or language planning difficulties. Increased processing demands/cognitive load during production of a narrative may result in increased dysfluency and more silent pauses. Even mild cases of aphasia (latent) produce pauses in their speech. Praat is a useful program for analyzing the duration of pauses in speech.

Dollaghan, C. & Campbell, T. (1992). A procedure for classifying disruptions in spontaneous language samples. *Topics in Language Disorders, 12*(2), 56-68.

Objective: To propose a detailed system for analyzing the disruptions in spontaneous language in order to provide a better understanding of a speaker's language production difficulties and therefore guide intervention practices. *Methods:* Participants included 10 children and adolescents between the ages of 7 to 20 years old who had received a

traumatic brain injury between two and four years previously, and 10 age-matched, non-injured and normally achieving peers. Twelve-minute conversational language samples were collected using a sequence of topic questions previously prepared by the researchers. The language samples were transcribed and coded for disruption types by using the Systematic Analysis of Language Transcripts (SALT). *Conclusion:* Results indicated similar overall patterns of disruption types in both groups of participants. The researchers suggest that the disruption taxonomy introduced in this study can be used reliably for clinical populations to assess and treat language-production processing deficits. *Relevance to current study:* A focus on disruptions (pauses) may provide clinicians with a better understanding of a speaker's language production difficulties and provide better starting points for intervention planning. The majority of pauses produced by adults are short. Lengthy pauses provide important clues regarding language production difficulties.

Dressler, R. A., Buder, E. H., & Cannito, M. P. (2009). Rhythmic patterns during conversational repairs in speakers with aphasia. *Aphasiology*, *23*(6), 731-748. https://doi.org/10.1080/02687030802165582

Objective: To examine changes in prosodic patterns during conversational repair episodes made by people with aphasia. It also explores how these patterns are influenced by conversational partner familiarity and perceived comprehensibility of the repair. *Methods:* Conversations were recorded and analyzed between speakers with aphasia and familiar and unfamiliar conversational partners. Prosodic tempo was defined as fluctuations in fundamental frequency (f_0) and sound pressure levels (SPL). Listeners judged the success of each repair and then compared changes in prosodic tempo from

pre-repair to post-repair speech. *Conclusion:* The prosodic tempo of speakers with aphasia was influenced by partner familiarity. Faster tempo was used with unfamiliar conversation partners during repairs and slower tempo with familiar partners. In addition, greater magnitudes of rhythmic change influenced the success of the repair. *Relevance to current study:* Studies have been done to examine changes in prosody (specifically tempo) made by people with aphasia during conversational repairs with familiar and unfamiliar partners. I am going to add to this research by exploring changes in prosody (specifically pitch and intensity) following extended pause during narrative retell in people with aphasia. The authors also suggest that SPL cycles similar to those identified in their study may represent changes in "prosodic output" that are affected by linguistic impairments. I am hoping to specify what those linguistic impairments are and how they can affect "prosodic output", namely pitch and intensity.

Faroqi-Shah, Y.& Thompson, C. (2010) Production latencies of morphologically simple and complex verbs in aphasia. *Clinical Linguistics & Phonetics, 24*(12), 963-979. https://doi.org/10.3109/02699206.2010.488314

Objective: To investigate whether morphological complexity influences verb production in individuals with agrammatic aphasia. *Methods:* Nine non-apraxic, agrammatic aphasic participants and nine unimpaired participants were presented with 40 words, with 10 words in each of the following categories: (1) verb stems (e.g., *fix*), (2) irregular past verbs (e.g., *froze*), (3) regular past verbs (e.g., *wrapped*), and (4) progressive aspectual verbs (also gerunds) with *ing* affixes (e.g., *dozing)*. Categories 1 and 2 were considered morphologically simple verbs and categories 3 and 4 were considered morphologically complex. *Conclusion:* The results indicate that "morphological complexity plays little

role, if any, in production difficulty". *Relevance to current study:* In this study I will investigate whether the characteristics of pause (length, frequency) are affected by the syntactic environment of an utterance in people with aphasia. This article states that individuals with agrammatic aphasia typically produce phonological errors and "morphosyntactically ill-formed utterances". This raises the question, how do the specific phonological and morphosyntactic errors typically produced by this population affect the location and duration of pauses in their speech?

Goldman-Eisler, F. (1958). Speech production and the predictability of words in context. *Quarterly Journal of Experimental Psychology, 10*, 96-106. https://doi.org/10.1080/17470215808416261

Objective: To discover if pauses indicate an increase of information in speech. *Methods:* Six cognitively healthy speakers participated in two experiments. In the first experiment, each participant was given some context about a particular topic and had one minute to guess each word in a target sentence. If the participant was unable to guess the word in the allotted amount of time, the target word was provided and they moved on to the next word in the sentence. This was repeated for seven different sentences. Results showed the transitional probability for words preceding pauses was more than the transitional probability for words following pauses. In the second experiment, the procedures for the first experiment were repeated except three participants were instructed to begin guessing with the first target word of the sentence, and three beginning with the last target word in the sentence. Words produced after pauses were very unpredictable and those before pauses were very predictable. *Conclusion:* Words produced after pauses were very unpredictable and words produced before pauses remained very predictable in both

forward and backward guessing. Pauses were usually found after high frequency words and before "words of highest information". The words following pauses had a higher mean length of letters per word than the words preceding pauses. *Relevance to current study:* Pauses generally occur before less semantically predictable words and before "words of highest information". In PWA, unpredictable words may include words produced in place of a more predictable word due to word-retrieval difficulties.

Kirsner, K., Dunn, J., Hird, K., Parkin, T., & Clark, C. (2002). Time for a pause. In *Proceedings of the Ninth Australian International Conference on Speech Science and Technology* (pp. 52-57). https://assta.org/proceedings/sst/sst2002/Papers/kirsner050.pdf

Objective: To introduce an analytic approach addressing and answering fundamental questions about pauses. *Methods:* 20 participants provided five two-to-five minute spontaneous speech samples. PRAAT software was used to identify the duration of pauses in each language sample. *Conclusion:* Log-normal distribution data revealed the presence of two distributions for pauses duration. Pause components are thought to reflect interactions between psycholinguistic variables and should not be categorized as only short or long. The authors suggest that threshold procedures be implemented regarding spontaneous speech analysis in communication disorders. *Relevance to current study:* Pause duration is affected by many if not all the variables related to lexical decision-making, including word frequency, age-of-acquisition, word length, and grammatical class. The use of pause plays a critical role in communication disorders, both in research and in practice. Typical speakers produce pauses at the rate of 30 or so per minute, 5 to ten hours a day.

Lasky, E. Z., Weidner, W. E., & Johnson, J. P. (1976). Influence of linguistic complexity, rate of presentation, and interphrase pause time on auditory-verbal comprehension of adult aphasic patients. *Brain and Language*, *3*(3), 386-395. https://doi.org/10.1016/0093-934X(76)90034-1

Objective: To see how altering the rate of speech presentation and varying pause time between major phrases within sentences of increasing syntactic complexity affects comprehension in people with aphasia. *Methods:* Participants included 15 aphasic patients, eight male and seven female, who were receiving speech therapy. Participants were between 19 and 75 years old and all had suffered from damage to the left cerebral hemisphere. Four equivalent sets of nine sentences each with three levels of syntactic complexity were used. Each was presented once at 120 words per minute (wpm) and 150 wpm, one time each with a 1 second interphrase pause time and once without pauses. *Conclusion:* Speech comprehension was improved across all levels of syntactic complexity when a slower rate of speech was combined with pause time between major phrases. *Relevance to current study:* Studies have been done to determine how pause duration and linguistic complexity affect auditory-verbal comprehension in patients with aphasia, but not (to this author's knowledge) of how linguistic complexity affects the production and duration of pause in these same individuals.

Levy, T., Silber-Varod, V., & Moyal, A. (2012, November). The effect of pitch, intensity and pause duration in punctuation detection. In *2012 IEEE 27th Convention of Electrical and Electronics Engineers in Israel* (pp. 1-4). IEEE.

Objective: To detect punctuation in read speech using only prosodic cues: pauses, changes in f_0, and intensity with no other lexical information or visual language model.

Methods: The speech samples for this study came from a speech corpus of American-English made up of two hours reading of George Orwell's *1984* by a professional narrator. The corpus included a transcription of the narration that was annotated and segmented using PRAAT software according to the punctuation marks included. Five prosodic features were used as input parameters and each received a different weight. The weights were summed up and a transfer function was created, using the numbers between 0 and 1 to indicate the probability of having the relevant punctuation mark. *Conclusion:* When punctuation was uttered without a pause, it dramatically reduced the rate of detection. Pitch and intensity gaps differentiated between speech and punctuation and between full-stops and commas. Full-stops were much easier to detect and commas were more easily detected when not followed by a pause. Even minimal prosodic elements provide critical information for the detection of punctuation in speech. *Relevance to current study:* Pauses, changes in pitch range and amplitude, melody and boundary tone distribution as well as speaking rate are all considered prosodic elements of speech. All of these are crucial for determining the boundaries of speech units across languages and improving intelligibility of verbal communication. When any of the elements of prosody are impaired, the speaker's ability to effectively communicate will be negatively impacted.

Mack, J. E., Chandler, S. D., Meltzer-Asscher, A., Rogalski, E., Weintraub, S., Mesulam, M. M., & Thompson, C. K. (2015). What do pauses in narrative production reveal about the nature of word retrieval deficits in PPA? *Neuropsychologia*, *77*, 211-222. https://doi.org/10.1016/j.neuropsychologia.2015.08.019

Objective: To examine the distribution of pauses across nouns and verbs produced in the narrative speech of individuals with primary progressive aphasia (PPA) and an age-matched control group of cognitively healthy speakers. *Methods:* Narratives about the story of "Cinderella" were collected from 3 groups of patients with PPA (12 with semantic variant PPA or PPA-S, 12 with agrammatic variant PPA or PPA-G, and 11 with logopenic PPA or PPA-L). These were compared to a cognitively typical control group of 12 participants. Word-finding pauses within these narratives were analyzed in terms of what type of word class the pause occurred near, how frequently they occurred, and how long they were. They also looked at the relationship between the occurrence of pause and cortical atrophy using MRI scans compared to the speech data. *Conclusion:* All groups produced more pauses before lower vs. higher frequency words. The PPA-L group produced more pauses before nouns compared to verbs. The PPA-G, PPA-S, and control groups produced similar pause rates across all word classes, however, lexical simplification (i.e. production of higher frequency and/or shorter words) was more evident in nouns for PPA-S and verbs for PPA-G. Atrophy in different brain regions can result in pauses occurring in different places. *Relevance to current study:* Pauses in individuals with PPA have been shown to occur with greater frequency before different word classes, depending on the specific type of PPA impairment/areas of atrophy.

Maclay, H., & Osgood, C. E. (1959). Hesitation phenomena in spontaneous English speech. *Word*, *15*(1), 19-44. https://doi.org/10.1080/00437956.1959.11659682

Objective: To investigate hesitation phenomena in spontaneously spoken English, specifically the use of filled and unfilled pauses, repeats, and false starts. *Methods:* The speech of 12 participants in a conference was tape recorded and transcribed. 163

utterances were produced by male speakers, all professional, and the transcribers were instructed to write exactly what was said, regardless of its grammatical accuracy. The frequency of the four hesitation types (filled and unfilled pauses, repeats, and false starts) was calculated per utterance, as well as the speed in words per minute. *Conclusion:* Filled pauses occurred relatively more frequently before function words and at phrase boundaries and unfilled pauses occurred relatively more frequently before lexical words and within syntactic phrases. However, both types of pauses occurred in any position and did so frequently. *Relevance to current study:* This article provides useful information regarding the typical use of pause in speech that can be used as a comparison to pause in the speech of aphasic individuals. The use of pause in speech can be influenced by the style of the speaker, with more pauses in emphatic or expressive speech. Pauses identify "linguistically relevant units" such as the boundaries of phonemes, morphemes, words, phrases, and sentences. In typical speech, pauses are often preceded by rising pitch, indicating continuation of the sentence. This article also suggests that the use of filled pause instead of silent pause may be an attempt to maintain control of a conversation.

Nevler, N., Ash, S., Irwin, D. J., Liberman, M., & Grossman, M. (2019). Validated automatic speech biomarkers in primary progressive aphasia. *Annals of Clinical and Translational Neurology*, *6*(1), 4-14. https://doi.org/10.1002/acn3.653

Objectives: To analyze and quantify specific disease biomarkers of prosody from the acoustic properties of speech in individuals with primary progressive aphasia. *Methods:* Speech samples from 59 progressive aphasia patients and 31 matched healthy controls were analyzed for acoustic measurements of prosody, including fundamental frequency and speech and silent pause durations. *Conclusions:* Nonfluent/agrammatic primary

progressive aphasia (naPPA) patients demonstrated reduced fundamental frequency (f_0) and increased pause rate in their speech, however, there was no "collinearity" between these two acoustic variables. This suggests that these two acoustic parameters are relatively independent of each other. *Relevance to current study:* Pause rate and prosody may function independently of one another in the speech of people with aphasia.

Pashek, G. V., & Tompkins, C. A. (2002). Context and word class influences on lexical retrieval in aphasia. *Aphasiology*, *16*(3), 261-286. https://doi.org/10.1080/02687040143000573

Objective: To study lexical retrieval of nouns and verbs in both connected speech and naming tasks in individuals with mild aphasia. *Methods:* 20 individuals with mild aphasia (primarily presenting as anomia) and 10 age- and education-matched controls participated in confrontation naming and video narration tasks with nouns and verbs as the targets. *Conclusion:* All participants demonstrated greater word finding difficulty for nouns than verbs, though post hoc analysis suggested this may have been influenced by word length and word frequency. Both groups also demonstrated less word finding difficulty in narratives than naming (possible due to increased activation of possible word candidates at the word production level). *Relevance to current study:* Individuals with aphasia demonstrated greater word finding difficulty with nouns than verbs (which may be influenced by word length and word frequency). This held true for both connected speech and naming tasks compared to the control group. Significantly more difficulty with lexical retrieval was experienced with two-syllable nouns than one-syllable nouns. This study also suggests the possibility that pauses occurring earlier in an utterance may indicate subtle word finding problems in planning stages for the utterance. This all may

be related to the relationship between pause and syntactic environment and/or morphological complexity of speech by aphasic individuals.

Reich, S. (1980). Significance of pauses for speech perception. *Journal of Psycholinguistic Research, 9*(4), 379–389. https://doi.org/10.1007/BF01067450

Objective: To determine if pause location has an effect on sentence comprehension and recall. *Method*: Participants consisted of four undergraduate students who were presented with 12 practice and 44 test sentences. Each sentence contained a pause in either a structural/grammatical (between clauses) or nonstructural (within a clause) location and participants were instructed to recall the sentence as quickly as possible after the presentation. Their response time, within-response pauses, and the accuracy of content were assessed. *Conclusions*: Participants took longer to recall sentences with pauses at nongrammatical locations and did so with more pauses and less accuracy. *Relevance to current study*: The placement of a pause in a sentence has an effect on listener perception and comprehension of speech.

Rochester, S. (1973). The significance of pauses in spontaneous speech. *Journal of Psycholinguist Research, 2*(1)**,** 51–81. https://doi.org/10.1007/BF01067111

Objective: To review previous studies on the significance of pauses for the speaker and discuss their importance in terms of cognition, affect, and social interaction. *Methods:* None – this was a systematic review. *Conclusion:* Further investigation is needed regarding the relationships between location and function of pauses in speech. *Relevance to current study:* The study of the location and conditions under which pauses occur in speech may provide answers to how the process of language production occurs. Pauses

are relevant to cognitive processing and to variables related to social and affective-state. The location of pauses in speech indicate lexical and structural levels of decision-making.

Rose, R. (2017). Silent and filled pauses and speech planning in first and second language production. In R. Eklund (Ed.), *Proceedings of Disfluency in Spontaneous Speech* (pp. 49-52). Royal Institute of Technology (KTH).

Objective: To study the relationship between silent and filled pauses and discourse and syntactic planning in bilingual individuals. *Methods:* Data was taken from a crosslinguistic corpus of speech containing speech samples of 35 Japanese speakers participating in a picture description and topic narrative task in both their first language and their second language (English). Their use of silent and filled pauses in each language was analyzed using PRAAT software. *Conclusion:* Silent pauses are more closely associated with problems at both utterance and clause boundaries than filled pauses, and therefore more closely associated with discourse and syntactic planning. *Relevance to current study:* This study provides a useful explanation of the difference between silent and filled pauses for introducing the use of typical speech in pause.

Rossi, E. (2015). Modulating the sensitivity to syntactic factors in production: Evidence from syntactic priming in agrammatism. *Applied Psycholinguistics, 36*(3), 639-669. http://dx.doi.org.erl.lib.byu.edu/10.1017/S0142716413000374

Objective: To investigate the agrammatic speech production of agrammatic Italian speakers using a particularly difficult linguistic structure (clitic pronouns) as a means to examine whether language performance might be influenced by syntactic priming. *Methods:* Spontaneous and elicited speech samples were collected from nine Italian agrammatic speakers and 10 Italian neurotypical speakers. Three experiments were

performed. The first was to collect, analyze, and compare the samples as a representative of the differences between agrammatic and neurotypical speakers and use it to provide a baseline to compare performance from experiments 2 and 3. Experiments 2 and 3 looked at whether the production of clitic pronouns in speakers with agrammatic aphasia (as well as the control group) would be influenced by syntactic priming. *Conclusion:* Agrammatic speakers are impaired in clitic production, however they showed residual sensitivity despite poor performance. Both the agrammatic and control speakers showed a positive effect for syntactic priming across clitic types. This suggests that agrammatism may be a linguistic processing deficit due to increased processing demands for complex linguistic structures. *Relevance to current study:* This article discusses several theories hypothesizing the underlying deficit in agrammatism (syntactic representations vs. accomplishing syntactic operations). It also discusses the importance of investigating the ability of people with aphasia to process complex linguistic structures. My study is looking at how linguistical complexity affects the speech (particularly use of pause) in people with aphasia. The study in this article allows us to examine how linguistic and cognitive processes work together during language processing in neurotypical speakers, as well as how we can apply this information to treatment for people with aphasia.

Saffran, E. M., Berndt, R. S., & Schwartz, M. F. (1989). The quantitative analysis of agrammatic production: Procedure and data. *Brain and Language*, *37*(3), 440-479. https://doi.org/10.1016/0093-934x(89)90030-8

Objective: To provide a procedural outline for the quantitative assessment of narrative speech (both morphological and structural characteristics) in people with aphasia. *Methods:* Six participants with Broca's aphasia (within 6 months or less post-stroke)

were divided into two groups: “agrammatical” subjects who frequently omitted at least some bound and free-standing grammatical morphemes, and “nonagrammatic” subjects who generally produced a variety of grammatical morphemes in their nonfluent speech. A control group of 5 patients was matched with the agrammatic subjects according to age, gender, and education. Each subject was asked to produce a narrative of a well-known fairy tale, preferably “Cinderella” and each language sample was transcribed and analyzed. *Conclusion:* Both the agrammatic and nonagrammatic participants produced structurally simple sentences, however the nonagrammatics had less difficulty generating minimal sentences (had greater proportion of words in sentences) and were less prone to morphological deviances, therefore producing more well-formed sentences compared to the agrammatics. *Relevance to current study:* Without a quantitative assessment of the morphological and structural characteristics of narrative speech in persons with aphasia, it is difficult to compare deficits across patients and to detect changes that occur in the patient’s speech with recovery or following therapy. Pauses in the speech of aphasic patients cannot be used as utterance boundaries as much as indications of a failure of lexical search. Agrammatic speech does not incorporate noun phrase-verb phrase structures and is deficient in bound and/or free grammatical morphemes, but not necessarily in both.

Schlenck, K. J., Bettrich, R., & Willmes, K. (1993). Aspects of disturbed prosody in dysarthria. *Clinical Linguistics & Phonetics*, *7*(2), 119-128. https://doi.org/10.3109/02699209308985549

Objective: To investigate how to assess disturbed prosody in dysarthria quantitatively. *Methods:* The prosodic characteristics of speech were analyzed in 84 German dysarthric

patients and 154 normal controls. These included length of tone units, fundamental frequency, and standard deviation of fundamental frequency. *Conclusion:* There were significant differences in prosody in the speech of the aphasia patients compared to the control group, as well as differences between those with mild versus severe dysarthria. Severe cases produced shorter tone units and higher mean fundamental frequencies than mild cases and normal controls. Mild cases produced lower standard deviations of fundamental frequency than severe cases and normal controls (i.e. their speech was more monotonous). *Relevance to current study:* People with aphasia often have dysarthria and may experience a similar impairment to the prosody of their speech.

Schlenck, K. J., Huber, W., & Willmes, K. (1987). "Prepairs" and repairs: Different monitoring functions in aphasic language production. *Brain and Language*, *30*(2), 226-244. https://doi.org/10.1016/0093-934x(87)90100-3

Objective: To analyze the type and amount of linguistic repairs and searching behavior or "prepairs" in aphasic individuals to provide further insight into the language processing abilities of this population. *Methods:* The study included six groups of 10 patients, three aphasic groups (including Wernicke's, Broca's, and amnesic aphasia) and three non-aphasic control groups. Linguistic data was collected using picture description subtests from the Aachen Aphasia Test (AAT). *Conclusion:* "Prepairs" were more frequent immediately before than after finite verbs. Patients showed more "prepairs" between rather than within noun phrases or prepositional phrases. All aphasic groups in the study produced most prepairs at clause boundaries, indicating difficulty with planning the production of more than one word at a time. They were unable to determine if this was due to lexical, semantic, syntactic, or morphological difficulties. There was no difference

in the use of repairs and prepairs in the speech of patients with Wernicke's versus Broca's aphasia. *Relevance to current study:* Pauses can be included in the author's description of "prepairs" as any searching behavior in the speech of aphasic patients. Longer pauses reflect trouble with language production. Repairs occurred less frequently than prepairs for both groups, indicating impaired "postarticulatory" monitoring compared to "prearticulatory" monitoring.

Seddoh, S. A. (2004). Prosodic disturbance in aphasia: Speech timing versus intonation production. *Clinical Linguistics & Phonetics*, *18*(1), 17-38. https://doi.org/10.1080/0269920031000134686

Objective: To examine the speech timing abilities of two groups of patients with fluent and nonfluent aphasia from a previous study by the author and determine if a relationship exists between their temporal control of speech and their use of intonation. *Methods:* Participants included 15 aphasic and 16 normal control subjects. Each aphasic participant was classified as fluent or nonfluent by two SLPs. 10 participants were classified as fluent (with a diagnosis of Conduction or Wernicke's aphasia) and five as nonfluent (Broca's aphasia). Speech samples were collected with 20 statements and matched echo questions. The acoustic signal for each speech production was displayed using CSpeech software. *Conclusion:* Patients with nonfluent aphasia demonstrated poor temporal control abilities and fluent aphasic patients performed similarly to the control group, although their durations were longer than normal. Results from this study do not show intonation production as being dependent on speech timing. *Relevance to current study:* Prosody includes certain characteristics of spoken language including length, loudness, and pitch. Acoustically, these correlate respectively as time or duration, intensity or

amplitude, and fundamental frequency. In addition, these acoustic properties correspond to the linguistic elements of length, rhythm, stress, intonation, and tone. This study will be looking specifically at how extended speech pauses disrupt the prosodic contours of an utterance.

Sheppard, S., Love, T., Midgley, K., Shapiro, L., & Holcomb, P. (2019). Using prosody during sentence processing in aphasia: Evidence from temporal neural dynamics. *Neuropsychologia, 134,* Article 107197. https://doi.org/10.1016/j.neuropsychologia.2019.107197

Objective: Investigates the syntactic function of prosody in a group of individuals with agrammatic aphasia. *Methods:* Ten adults with agrammatic aphasia and 19 age-matched controls participated in the study. Event-related potentials (ERPs) were used to investigate how syntactic complexity in the form of early vs. late closure prosody could impact intonational phrase boundary processing (as measured by closure positive shift (CPS). 120 sentences with early and late closure syntactic structure were recorded by typical speakers with intonational phrase boundaries used in various locations of the sentences. The aphasia and control groups listened to the sentences over headphones and were asked to make acceptability judgments after each sentence. *Conclusion:* The aphasia group demonstrated delayed prosodic processing. *Relevance to current study:* It is important to examine the relationship between prosodic and syntactic cues in people with agrammatic aphasia, because in addition to nonfluent speech production, they have a sentence comprehension deficit when it comes to understanding syntactically complex sentences. This article also provides useful information about the role of prosody in speech comprehension.

Tang, K. & Shaw, J. A. (2021). Prosody leaks into the memories of words. *Cognition, 210,* Article 104601. https://doi.org/10.1016/j.cognition.2021.104601

Objective: To explore the relationship between prosody and predictability and whether the effects of predictability on word duration found in past studies generalizes to pitch and intensity. *Methods:* 1,793 Mandarin Chinese speakers were assigned a specific topic to discuss during a 10-minute conversation with an unfamiliar conversation partner over the telephone. The conversations were transcribed and acoustic measurements were used to analyze the duration, intensity, and pitch of each word. *Conclusion:* The predictability of a word directly influences word duration, maximum pitch, and maximum intensity. *Relevance to current study:* Words produced under sentential stress are often produced with greater duration, intensity, and pitch excursions. Prosodic prominence is affected by the frequency and informativity (average predictability) of a word. In typical speakers, emphasis is often given to words that introduce new information to the discourse. Listeners also judge less predictable words to be more prominent. Words generally take on the phonetic characteristics of the prosodic contexts in which they are typically used. The intensity and pitch of words following an extended pause (words offering new information/produced under sentential stress due to word-finding difficulties) in PWA may be affected.

Zellner, B. (1994). Pauses and the temporal structure of speech. In E. Keller (Ed.), *Fundamentals of speech synthesis and speech recognition* (pp. 41-62). John Wiley.

Objective: To provide a description of the temporal structure of speech (such as pauses, syllable prolongations, and overall timing) and how they work together to contribute to natural-sounding speech synthesis. *Methods:* This is a book chapter providing a

description and not a scientific study. *Conclusion:* This chapter provides a description of the difference between silent and filled pauses and how perceived pauses generally support grammar, semantics, hesitation, etc. The location and duration of pauses depend on the physiological aspects of speech motor behavior and cognitive processes. Pauses tend to occur between rhythmic groups. Pause is an important characteristic of the prosody of speech. *Relevance to current study:* This article provides information on the function of pause in speech, including its role in improving the intelligibility of speech, its increased occurrence according to the complexity of the speech task, its role in typical and dysfluent speech, as well as the important contribution it makes to speech prosody.