2021-06-16

Correlations Between Cognitive Pause Patterns and Listener Perceptions of Communicative Effectiveness and Likeability for People With Aphasia

Heidi Raylene McConaghie
Brigham Young University

Correlations Between Cognitive Pause Patterns and Listener Perceptions

of Communicative Effectiveness and Likeability

for People With Aphasia

Heidi Raylene McConaghie

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

Shawn L. Nissen, Chair
Tyson G. Harmon
Kathryn L. Cabbage

Department of Communication Disorders

Brigham Young University

ABSTRACT

Correlations Between Cognitive Pause Patterns and Listener Perceptions
of Communicative Effectiveness and Likeability
for People With Aphasia

Heidi Raylene McConaghie
Department of Communication Disorders, BYU
Master of Science

A prevalent feature of typical spontaneous speech are speech pauses. Longer speech pauses, known as cognitive pauses, occur in typical speech and are indicative of higher-level cognitive processes. Atypical cognitive pauses, however, are prevalent in the speech of people with aphasia consequent to their communication disorder. Research has shown that these atypical pauses may contribute to negative listener perceptions. This study aimed to determine the influence of atypical speech pause on listener perceptions of communicative effectiveness and speaker likeability. Specifically, this study evaluated the relationship between listener ratings of communicative effectiveness and likeability and acoustic measures of between-utterance pause duration, within-utterance pause duration, and the location of within-utterance pauses. This study also examined the relationship between listener ratings of communicative effectiveness and likeability. Target stimuli included 30-second samples of speech from two individuals with mild aphasia and four with moderate aphasia. Using a visual analog scale, 40 adult listeners listened to these speech samples and rated each sample according to the speaker's communicative effectiveness and likeability. Overall, listeners were not as sensitive to between-utterance pauses. While listeners were more sensitive to within-utterance pauses greater than one second, they were similarly impacted by within-utterance pauses between 250-999 milliseconds. Listeners were also more affected by pauses at the beginning of an utterance than at the end of an utterance. Results also demonstrated a strong positive correlation between listener ratings of communicative effectiveness and likeability. In general, results suggest that the location and length of pauses in the speech of people with aphasia have an impact on listeners' perceptions. In combination with future research, the results of this study will provide a deeper understanding of the impact of cognitive pause in people with aphasia, thus improving future clinical assessment and treatment of aphasia.

Keywords: cognitive pause, aphasia, communicative effectiveness, likeability

ACKNOWLEDGMENTS

I would like to express appreciation for everyone who has supported and encouraged me throughout my thesis project and graduate program. I would like to express my sincere gratitude to Dr. Nissen, my thesis chair, for giving me the opportunity to work with him on this project and for providing me with guidance, motivation, empathy, and friendship throughout my undergraduate and graduate programs. I would also like to thank my committee members, Dr. Harmon and Dr. Cabbage, for their invaluable insights and suggestions throughout the research process. I am very grateful for the work of Emily Wright, Julia Price, and Brooke Thomas, as their work greatly contributed to the success of this project as a whole. I am also thankful for the listeners that participated in this study, as this thesis would not have been completed without them. Lastly, I would like to express my appreciation to all of my family and friends, who have always shown me love, support, and kindness, as I have worked towards achieving my dream of becoming a speech-language pathologist.

TABLE OF CONTENTS

TITLE PAGE i

ABSTRACT ii

ACKNOWLEDGMENTS iii

TABLE OF CONTENTS iv

LIST OF TABLES vi

LIST OF FIGURES vii

DESCRIPTION OF THESIS STRUCTURE viii

Introduction 1

Functions of Cognitive Pause 1

Atypical Cognitive Pause 3

Cognitive Pause in People With Aphasia 4

Clinical Assessment of Cognitive Pause in People With Aphasia 6

Purpose of This Study 7

Method 8

Participants 8

Stimuli 8

Perceptual Rating Procedures 9

Acoustic Measurement of Speech Samples 10

Statistics 12

Measurement Reliability 12

Results 12

Between Utterance Pause Durations 12

Within Utterance Pause Durations 13
Pause Duration Utterance Location 14
Listener Rating Correlations 15
Discussion 16
Between Utterance Pause Durations 16
Within Utterance Pause Durations 17
Pause Duration Utterance Location 18
Listener Rating Correlations 19
Limitations 19
Conclusions 20
References 21
APPENDIX A: Annotated Bibliography 28
APPENDIX B: Informed Consent 59

LIST OF TABLES

Table 1 *Demographic Information of People With Aphasia* 9

Table 2 *Descriptive Statistics of Between-Utterance Pause Durations and Associated Correlations* 13

Table 3 *Descriptive Statistics of Within-Utterance Pause Durations and Associated Correlations* 14

Table 4 *Descriptive Statistics of Within-Utterance Pause Means in Varying Locations of a Sentence and Associated Correlations* 15

Table 5 *Descriptive Statistics of Listener Ratings and Associated Correlations* 15

LIST OF FIGURES

Figure 1 *Visual Analog Scale Used by Listeners to Submit Perceptual Ratings* 11

DESCRIPTION OF THESIS STRUCTURE

This thesis, *Correlations Between Cognitive Pause Patterns and Listener Perceptions of Communicative Effectiveness and Likeability for People With Aphasia,* is part of a larger study exploring the impact of cognitive 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 Appendix A, and the consent form used in this study is provided in Appendix B.

Introduction

A prevalent feature of typical speech are pauses, or periods of temporary silence that separate words, phrases, or sentences in running speech. While speech pauses occur in almost all spontaneous speech, the frequency and duration of these pauses significantly vary across speakers and utterances (Goldman-Eisler, 1958). Researchers believe that these pauses may serve distinct functions in speech (Angelopoulou et al., 2018), and as a result, many studies have been conducted to examine how pause contributes to the overall effectiveness or possible impairment of communication.

Functions of Cognitive Pause

Short and long speech pauses can contribute to the effectiveness of communication. Short pauses provide the speaker with time to articulate and breathe during speech (Angelopoulou et al., 2018). Research has shown that typical speakers also use longer pauses, what we refer to herein as cognitive pauses, to signify an increase in information (Goldman-Eisler, 1958), to indicate word and syntactic boundaries (Esposito et al., 2007), and to mark boundaries between narrative elements (Esposito, 2005). These cognitive pauses in speech denote the occurrence of higher-level processes in the mind of the speaker (Angelopoulou et al., 2018). In particular, research has shown that cognitive pauses are associated with the processes of lemma activation and selection (Goldman-Eisler, 1958). Other studies have provided evidence that these longer pauses provide speakers with additional time to retrieve the information they wish to express from their memories (Esposito et al., 2007), to process an increased cognitive load (Esposito, 2005; Greene & Lindsey, 1989), and to syntactically plan their message (Angelopoulou et al., 2018).

Pauses during spontaneous speech have also shown to benefit the listener in a conversation. These pauses help the listener identify grammatical boundaries (Reich, 1980), thoroughly process a speaker's utterance (Ratcliff et al., 2002), and prepare himself or herself for any upcoming utterances from the speaker (O'Connell et al., 1969). For example, research has found that listeners are more accurately able to recall a series of numbers and letters spoken at an increased rate when silent pauses are dispersed throughout the list (Aaronson, 1968). In addition, augmentative and alternative communication literature suggests that when 10-second pauses are inserted between words in synthetic speech, the listeners' ability to understand the spoken message is significantly increased (Higginbotham et al., 1994). Thus, cognitive pauses in communication help the listener process a speech signal to better comprehend the message.

While cognitive pauses can increase a listener's comprehension, they can significantly affect the listener's perception of speech fluency and naturalness. Speech fluency has been described as an "impression on the listener's part that the psycholinguistic processes of speech planning and speech production are functioning easily and efficiently" (Lennon, 1990, p. 391). Research has shown that one of the main factors that contributes to this listener's perception of speech fluency is speech rate (Bosker et al., 2012). Speech rate is highly influenced by the relative length of pauses as it is calculated by dividing a speaker's total number of words or phonemes by the total time taken (including pauses) to express the message (Vojtech et al., 2019). Studies have shown that when more and longer pauses are included in both typical and synthetic speech, listeners are less tolerant and perceive the speech to be less natural than when speech contains fewer and shorter pauses (Yorkston et al., 1990; Ratcliff et al., 2002). Thus, as the number and length of cognitive pauses increase, speech rate decreases, and listener ratings of the speaker's fluency and naturalness also decrease.

Atypical Cognitive Pause

Communication can also be influenced by atypical cognitive pauses. In the speech of typical speakers, uncharacteristically long pauses often occur before unpredictable words (Beattie & Butterworth, 1979), content words (Maclay & Osgood, 1959), and words that are highly specific to a particular context (Goldman-Eisler, 1958). Research suggests that atypical pauses can also occur when a significant cognitive load is placed on an individual (Greene & Lindsay, 1989). However, when individuals are given advanced notice to prepare their message before speaking, the cognitive load is reduced and the number and length of pauses in the individuals' speech is also reduced (Greene, 1984; Greene & Lindsay, 1989).

Atypical pauses can also occur in an individual's speech as cognitive changes take place following neurophysiologic impairment due to aging, injury, or disease. For instance, one study showed that as a person ages and his or her cognitive state is slightly altered, that individual begins to insert pauses at abnormal linguistic locations (Lee et al., 2019). Cognitive pauses in speech may also be altered by neurological disorders. Studies of patients with primary progressive aphasia have revealed that these patients have greater overall pause rates compared to neurotypical controls, which is indicative of their word-finding difficulties in conversation (Mack et al., 2015). Patients with amyotrophic lateral sclerosis (ALS) have been reported to produce variable pause patterns with more frequent and longer pauses than typical speakers, leading to a decline in their speech intelligibility (Green et al., 2004; Rong et al., 2016). These unique pause characteristics help researchers and medical professionals track changes in the progression of bulbar ALS (Barnett et al., 2020). In addition, individuals with a traumatic brain injury pause significantly more times between clauses than typical individuals do because of sentence planning difficulties (Peach, 2013). Lastly, individuals with Parkinson's disease include more pauses of increased length within utterances compared to age-matched controls (Smith et al., 2018), thus reducing their speech rate and disrupting their fluency. Researchers believe that these abnormal pauses help people with Parkinson's disease organize and plan for their subsequent utterances (Ash et al., 2012). Collectively, these studies suggest that pause patterns differ between individuals with neurological disorders and typical individuals, which may have an impact on their communicative effectiveness.

Cognitive Pause in People With Aphasia

Cognitive pauses are also present in the speech of people with aphasia (PWA). Their pause patterns mimic the pause patterns of neurotypical individuals in that both long and short pauses are present in their speech; however, compared to neurotypical individuals, PWA produce more pauses in their speech (Angelopoulou et al., 2018). Furthermore, the relative duration of these cognitive pauses is often greater in the speech of PWA. This increase in speech pause quantity and length can result in difficulties in communication (Angelopoulou et al., 2018), especially in noisy environments that can place a greater demand on the attention required to process and formulate language from both the speaker and the listener (Baylor et al., 2011; Harmon et al., 2019; Murray, 2000). Studies also suggest that atypical speech pause patterns arise due to the difficulties PWA have with lexical retrieval, processing speed, and language planning (DeDe & Salis, 2020). Additional time is needed for PWA to carry out these cognitive linguistic processes, and atypical pauses provide PWA with additional time (Angelopoulou et al., 2018). Additionally, several studies have suggested that the language difficulties PWA experience cause them to have stress and anxiety about speaking tasks, which negatively impacts their speaking performance (Laures-Gore et al., 2010; Cahana-Amitay, Albert, et al., 2011, Cahana-Amitay, Oveis, et al., 2015; Harmon et al., 2020).

While the exact cause of atypical pauses in PWA is unknown, research suggests that these atypical pauses can substantially impair the communication effectiveness of PWA. A study by Allard and Williams (2008) examined the opinions of 445 listeners upon hearing an actor present with an articulation disorder, a fluency disorder, a voice disorder, and a language disorder (Wernicke's aphasia). The results of this study indicated that listeners perceive individuals with Wernicke's aphasia to be less decisive, less reliable, and more stressful than individuals with other types of communication disorders. Allard and Williams reported that listeners generally perceive these individuals to have lower self-esteem, to be less intelligent, and less employable than individuals with no disorder. In other studies, many PWA have reported that listeners do not view them as a "whole person" (Dalemans et al., 2010) and therefore treat them differently than individuals with typical speech communication. They have remarked that even their communication partners may think of them as being incompetent and disregard their desires and capabilities (Dalemans et al., 2010). Unfortunately, these negative perceptions may also extend to an individual's family and friends. Researchers found that PWA receive lower ratings from their spouses in the categories of likeability, endurance, achievement, and order compared to typical individuals (Croteau & LeDorze, 2001). Hence, a speaker's aphasia may lead to more negative perceptions from both unfamiliar and familiar communication partners.

One of the factors that may contribute to the impaired communication of PWA may be in part the presence of atypical cognitive pause during their speech. In a recent study (Harmon et al., 2016), researchers compared listener perceptions of aphasic audio samples to simulated fluent aphasic audio samples. To create these simulated fluent audio samples, researchers used audio software to delete silent pauses greater than 0.4 seconds, filled pauses, fillers, repetitions, and revisions from a collection of audio samples obtained from PWA. Any other aphasic speech and language characteristics, such as agrammatism and paraphasias, were left in the samples. The results of this study revealed that listeners perceived the speakers of the aphasic audio samples to be less intelligent, less confident, less competent, and less friendly than the speakers of the simulated aphasic samples. The listeners participating in the study also felt less comfortable, less patient, and reported expending more effort when listening to the speakers of aphasic audio samples compared to the speakers in the simulated aphasic samples. As the deletion of silent pauses was included in the creation of the simulated fluent audio samples, this study suggests that atypical cognitive pause contributes (as one of several disfluent behaviors) to a listener's perception of the communicative ability of PWA (Harmon et al., 2016).

Clinical Assessment of Cognitive Pause in People With Aphasia

When carrying out assessments of speech functioning in PWA, speech-language pathologists often formally or informally evaluate a speaker's patterns of pause during speech. For example, when administering specific subtests of the Quick Aphasia Battery (QAB), clinicians give full points to a patient who begins a correct response within 3 seconds, partial credit if the patient begins a response between 3 and 6 seconds, and no points if the patient begins a response after 6 seconds. Clinicians are also asked to note if the patient includes a pause of 3 seconds or more within their response (Wilson et al., 2018). In contrast, the word comprehension and naming portions of the Boston Diagnostic Aphasia Examination (BDAE) instruct clinicians to give their patients full points if a correct response is provided within 5 seconds (Goodglass & Kaplan, 1972). Finally, the Western Aphasia Battery Revised (WAB-R; Kertesz, 2006) advises clinicians to allow a patient 20 seconds to provide a correct response when asked to name an object. Each of these assessments of aphasia distinguish cognitive pause as an important clinical marker; however, the time allotted for cognitive pause significantly differs in each assessment, and limited information has been provided regarding how each clinical assessment selected these differing degrees of pause. This limited information may be due in part to the paucity in the research on the correlation between the relative length of pause and the impact on a speaker's communication. Furthermore, it may be significant for clinicians to also note the location of their patients' pauses during these clinical assessments, as pause location between words, phrases, and sentences may impact communication differently. However, few studies have provided evidence of the relationship between pause location and communication effectiveness, especially in PWA.

Purpose of This Study

While a number of clinical assessment batteries for aphasia evaluate cognitive pause, it remains unclear as to what the significance of these data may be for both the clinician and the patient. To address this issue, this study aimed to determine the influence of atypical speech pause on the perception of communicative effectiveness and personal attributes. Specifically, this study aimed to address the following research questions:

1. Is there a statistically significant relationship between the listener ratings of communicative effectiveness and likeability and measures of between-utterance pause durations?
2. Is there a statistically significant relationship between the listener ratings of communicative effectiveness and likeability and measures of within-utterance pause duration?
3. Does the association between the listener ratings and the within-utterance pauses change as a function of where it is located in the utterance?

4. Is the correlation between the listener ratings of communicative effectiveness and likeability significant?

Method

The data collected in this thesis was part of a joint research project examining the influence of atypical speech pause in people with aphasia on listener perceptions of communicative effectiveness and likability. As a result, the testing procedures and data collection are similar to the methods used in other projects of the larger study (e.g., Wright, 2021).

Participants

Participants for this study included 40 adult native English-speaking listeners, 24 females and 16 males, ranging in age from 18 to 65 years. Listeners were recruited from the undergraduate program of communication disorders as well as from the general community. Each listener signed an informed consent document and passed a hearing screening at 25 dB HL at one-octave frequencies from 500 to 8,000 Hz prior to participating in this study. This study and its methods were approved by Brigham Young University's Institutional Review Board.

Stimuli

The stimulus items evaluated in this study were extracted from speech audio samples previously collected in a research project by Harmon (2018). The stimulus items consisted of 30-second samples of speech produced by six randomly selected individuals with aphasia. As shown in Table 1, two of these individuals presented with mild aphasia, and four presented with moderate aphasia as measured by scores on the Aphasia Quotient on the Western Aphasia Battery (WAB-AQ). The speech audio samples evaluated in this study were elicited by asking PWA to retell a story to a supportive communication partner.

Each stimulus item was extracted from the original audio recording using Adobe Audition sound editing software and normalized for intensity. Five of the 30-second stimulus items were taken from the beginning of each original audio sample. The sixth stimulus item was extracted as close to the beginning of the original audio sample as possible without including profane content. The samples were filtered to eliminate any residual electronic noise or noise artifacts that may distract the listeners. The duration of each speech sample was edited to include 500 ms of silence preceding the onset of each speech sample.

Table 1

Demographic Information of People With Aphasia

ID	Gender	Age	WAB-AQ	Aphasia Type	Aphasia Severity
1	Female	59	89.90	Anomic	Mild
2	Female	65	84.30	Anomic	Mild
3	Female	61	67.50	Broca's w/Apraxia	Moderate
4	Male	60	75.00	Anomic	Moderate
5	Female	56	52.10	Broca's w/Apraxia	Moderate
6	Male	48	68.20	Broca's w/Apraxia	Moderate

Perceptual Rating Procedures

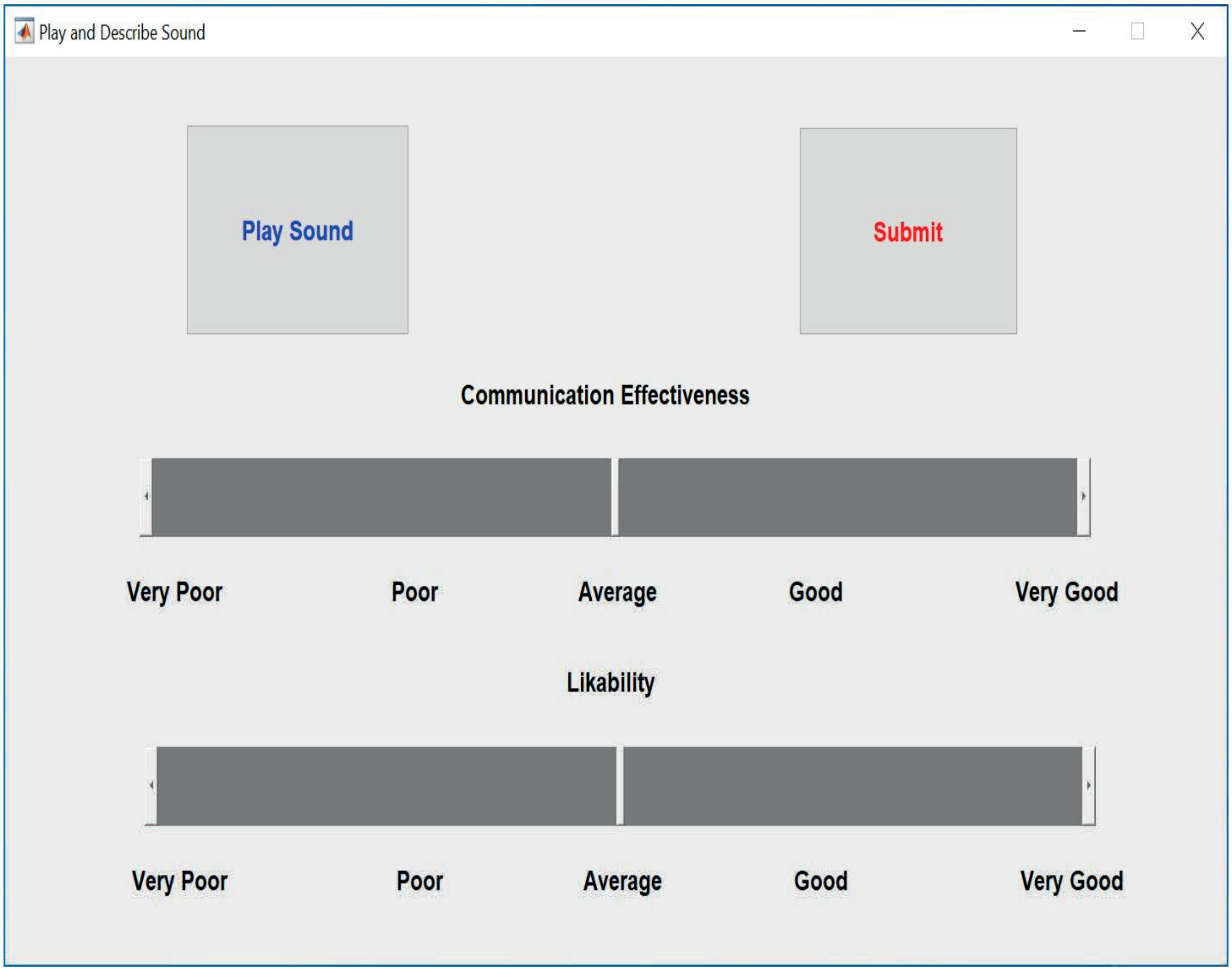
The previously mentioned native English-speaking listeners were asked to evaluate speech sound sample recordings of people with aphasia, and to rate their perception of the speaker's communicative effectiveness and personal attributes. The participants completed the listener ratings in one 45-minute session, with a 3-minute break between two 20-minute listening sessions. Prior to data collection, listeners participated in a hearing screening and practice session. Stimulus items were randomly presented to the participants in a double-walled sound booth via Sennheiser 650 HD open back headphones. The starting intensity level for all audio signals was set at 60 dB HL; however, each participant was allowed to adjust the intensity to a comfortable level, within the range of safe hearing levels. Participants were instructed to listen to each 30-second speech sample and then rate their perception of the speaker's communicative effectiveness and likability using a visual analog scale, as shown in Figure 1. Each participant was asked to categorically rate each speech sample for communicative effectiveness and speaker likeability along a continuum ranging from "very poor" to "very good." These categorical ratings were converted to a scale of 0-100 preceding statistical analysis. Participants were instructed to listen to the entire length of each speech sample before submitting their ratings. Participants were also asked to individually rate each speech sample and to avoid comparing the speech samples to one another. Stimulus items were randomly separated by foil stimuli that consisted of eighteen modified audio samples produced from the same six aphasic speakers used in this study and one hundred twenty-six audio samples produced by two typical adult speakers. The perceptual ratings for foil stimuli were not incorporated in this study's statistical analysis.

Acoustic Measurement of Speech Samples

Using PRAAT acoustic analysis software (Boersma & Weenink, 2021), the acoustic measures of the within-utterance mean pause (pause between each word in an utterance) and the between-utterance mean pause length were calculated for each of the speech samples rated by the listeners in the perceptual experiment described above. The number of pauses of differing lengths (i.e., 250 – 499 ms, 500 – 749 ms, 750 – 999 ms, and > 1 second) were also measured for each speaker sample. The number of pauses of varying lengths included any filled pause that did not contain a word with communicative content. Pause length proportions within-utterances were calculated by dividing the number of pauses at each duration by the total number of words within each sample. Pause length proportions between-utterances were calculated by dividing the number of

Figure 1

Visual Analog Scale Used by Listeners to Submit Perceptual Ratings



pauses greater than 1 second by the total number of utterances, or in other words by the total number of independent clauses, within each sample. As this project was part of a larger study, some of these acoustic measures were taken from a previous project (Thomas, 2021), and some measures were calculated specifically during this study. Measurement reliability was examined by having a second rater measure the pause from 20% of the speech samples, which were then correlated to the original measurements.

Statistics

Pearson Correlation analyses were used to correlate the associations between the acoustic measures and the listener ratings of communicative effectiveness and speaker likeability. The association between the two sets of listener ratings was also evaluated by the correlational analyses.

Measurement Reliability

To examine reliability of the listener ratings in this study, each listener randomly rated 20% of the stimuli a second time. The first and second sets of ratings had a Pearson correlation of $r = .64$, $p < .0001$ for communicative effectiveness, with a mean absolute difference of 6.75 (on a scale of 0 – 100). Both sets of ratings were correlated at $r = .75$, $p < .0001$ for likeability, with a mean absolute difference of 12.43.

Results

Descriptive statistics of the mean, standard deviation, and range of the acoustic measures and listener ratings are reported in tabular form below, according to the research question being addressed. The correlation probabilities and degrees of association are also reported, with differing font colors distinguishing between small (green), moderate (blue), and large (red) associations.

Between Utterance Pause Durations

The between-utterance acoustic means and standard deviations, as well as the associated correlation values are detailed in Table 2 below. The listener ratings for communicative effectiveness exhibited a small association with between-utterance pause mean, $r(240) = .13$, $p < .05$. No other significant associations were found.

Table 2

Descriptive Statistics of Between-Utterance Pause Durations and Associated Correlations

Variable	*n*	*M*	*SD*	Effectiveness	Likeability
1. Between-utterance pause mean [a]	240	808.0	210.9	.13*	.01
2. Between-utterance pauses > 1 sec.	240	28.5	10.9	.01	-.07

Note. Degrees of association: small (green), moderate (blue), large (red).

[a] Calculated in milliseconds.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Within Utterance Pause Durations

As shown in Table 3, results of the Pearson correlation indicated that there were significant negative associations between several measures of within-utterance pause and the listener ratings for communicative effectiveness and likeability. The acoustic variables of within-utterance pause durations between 250 - 499 ms, between 500 - 749 ms, and between 750 - 999 ms exhibited a small negative association with both listener ratings. A small negative association was also found between the listener ratings for likeability and the acoustic variables of within-utterance pause mean, $r(240) = -.22$, $p < .001$, and within-utterance pause durations greater than or equal to 1000 ms, $r(240) = -.24$, $p < .001$. The listener ratings for communicative effectiveness demonstrated a moderate association with within-utterance pause mean, $r(240) = -.34$, $p < .001$, and within-utterance pause durations greater than or equal to 1000 ms, $r(240) = -.38$, $p < .001$.

Table 3

Descriptive Statistics of Within-Utterance Pause Durations and Associated Correlations

Variable	*n*	*M*	*SD*	Effectiveness	Likeability
1. Within-utterance pause mean [a]	240	492.8	192.9	-.34***	-.22***
2. 250 [b]	240	9.4	6.1	-.22***	-.16**
3. 500 [c]	240	8.7	4.6	-.12	-.12
4. 750 [d]	240	6.6	3.1	-.19**	-.14*
5. 1000 [e]	240	18.3	9.4	-.38***	-.24***

Note. Degrees of association: small (green), moderate (blue), large (red).

[a] Calculated in milliseconds. [b] Pause durations between 250-499 milliseconds. [c] Pause durations between 500-749 milliseconds. [d] Pause durations between 750-999 milliseconds. [e] Pause durations greater than 1000 milliseconds.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Pause Duration Utterance Location

The within-utterance pause means and standard deviations, as well as the associated correlation values are outlined in Table 4 below. The results of the Pearson correlation demonstrated several significant negative associations between within-utterance pauses throughout a sentence and listener ratings of communicative effectiveness and likeability. The acoustic variable of within-utterance final mean exhibited a small negative correlation with both listener ratings. The acoustic variables of within-utterance pause mean, $r(240) = -.22$, $p < .001$, within-utterance initial mean, $r(240) = -.24$, $p < .001$, and within-utterance medial mean, $r(240) = -.20$, $p < .01$, demonstrated a small negative correlation with the listener ratings for likeability. The strongest negative association was found between the acoustic ratings of within-utterance pause mean, $r(240) = -.34$, $p < .001$, within-utterance initial mean, $r(240) = -.38$, $p < .001$, and within-utterance medial mean, $r(240) = -.32$, $p < .001$, and the listener ratings for communicative effectiveness.

Table 4

Descriptive Statistics of Within-Utterance Pause Means in Varying Locations of a Sentence and Associated Correlations

Variable	*n*	*M*	*SD*	Effectiveness	Likeability
1. Within-utterance pause mean [a]	240	492.8	192.9	-.34***	-.22***
2. Within-utterance initial mean [a]	240	507.9	187.3	-.38***	-.24***
3. Within-utterance medial mean [a]	240	476.7	177.2	-.32***	-.20**
4. Within-utterance final mean [a]	240	481.6	231.0	-.28***	-.20**

Note. Degrees of association: small (green), moderate (blue), large (red).

[a] Calculated in milliseconds.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Listener Rating Correlations

As displayed in Table 5, the results of the Pearson correlation between the acoustic variables of effectiveness and likeability exhibited a moderate positive correlation, $r(240) = -.39$ $p < .001$.

Table 5

Descriptive Statistics of Listener Ratings and Associated Correlations

Variable	*n*	*M*	*SD*	1	2
1. Effectiveness	240	22.4	19.3	—	.39***
2. Likeability	240	43.8	22.9	.39***	—

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Note. Degrees of association: small (green), moderate (blue), large (red).

Discussion

The overall purpose of this study was to provide experimental data of the influence of atypical speech pause on a listener's perception of communicative effectiveness and the speaker's likeability. The specific findings of each research question will be addressed below.

Between Utterance Pause Durations

The first research question examined in this study was if there was a statistically significant relationship between the listener ratings of communicative effectiveness and likeability and measures of between-utterance pause durations? The results of the study indicated that there were relatively small correlations between the acoustic measure of between-utterance pauses and the listener ratings of communicative effectiveness and likeability. There was a small association between the measure of between-utterance pause mean and the listener rating of communicative effectiveness; however, a possible limitation of this study may be that the between-utterance mean may not accurately capture the pause characteristics of the speech of PWA, as pauses in the speech of PWA are highly variable. Due to the inconsistency of these pauses, the mean may not accurately portray the full continuum of pause length in PWA as it averages the shorter and longer pauses. Results also showed that pauses between utterances that were greater than 1 second did not seem to impact the listeners ratings. One possible reason for these results may be that a listener expects between-utterance pauses, and therefore, does not consider these pauses greater than one second to be atypical. This finding supports previous research that states that typical pauses help the listener identify grammatical boundaries (Reich, 1980), cognitively process a speaker's utterance (Ratcliff et al., 2002), and prepare for any additional utterances from the speaker (O'Connell et al., 1969). A limitation to this study, however, may be that it only analyzed pauses that were greater than 1 second and no longer durations such as 2 or 3 second pauses. It would also be of value to gather more data from typical speakers to better understand what lengths of pauses typical speakers include between their utterances. Despite these limitations, research regarding between-utterance pauses in disordered speech is very limited and thus these findings may give us insight into the impact of between-utterance pauses in the speech of PWA.

Within Utterance Pause Durations

The second research question evaluated the relationship between the listener ratings of communicative effectiveness and likeability and measures of within-utterance pause duration? The findings of this study illustrated that the correlations of effectiveness and likeability with the acoustic measure of within-utterance pause mean show a moderate and small negative association respectively, or in other words, listener ratings decreased when pauses increased. However, similar to the between-utterance mean, the acoustic measure of within-utterance pause mean may not be the best measure to use due to the bimodal nature of the pause durations, some being very short and others relatively long (Hird & Kirsner, 2010). Thus, the correlations involving the pause measures of differing lengths (i.e., 250 – 499 ms., 500 – 749 ms., 750 – 999 ms., and > 1 second) may be more valuable in interpreting the impact of pause on communicative effectiveness and likeability. The within-utterance pauses between 250-999 milliseconds showed a small association with listener ratings, but this association increased when within-utterance pauses were over 1 second, thus indicating that listeners found the within-utterance pauses in the samples from PWA to be less typical when they were greater than 1 second. This finding supports current research indicating that individuals with aphasia have longer pauses within utterances than typical speakers do (Angelopoulou et al., 2018), and these longer pauses may cause a listener to feel less comfortable listening to the speaker (Harmon et al., 2016), thus rating the speech of PWA more poorly. This study's results demonstrate that there is a categorical change in how listeners interpret pause when it is longer than 1 second. This finding supports the need for taking a closer examination at within utterance pauses greater than 1 second in future studies to determine their impact on listener ratings. It would also be interesting to compare these results with listener perceptions of varying lengths of within-utterance pauses in childhood and acquired apraxia of speech as Shriberg and colleagues (2017a, 2017b) suggest that one diagnostic marker of these populations is within-utterance pauses between 150-750 ms.

Pause Duration Utterance Location

The third research question investigated how listener ratings differed as a function of where the extended pause was located in the utterance? Results indicated that the negative associations between the acoustic measures and listener ratings were slightly larger towards the beginning of the utterance compared to the end of an utterance. In other words, listeners were more affected by pauses at the beginning of an utterance than at the end of an utterance. One reason listeners may not be as affected by pauses near the end of an utterance may be that they are more forgiving of these pauses as they are expecting some sort of pause to indicate grammatical boundaries. Listeners may not be as forgiving of pauses near the beginning of an utterance as these pauses may disrupt their attempt at identifying and processing the speaker's topic. In future studies, it would be of interest to count the number of pauses within each third of the sentence to determine whether the number of pauses influenced the listener ratings. The current literature with regard to utterance location and the impact of pause is limited, and therefore, it is hoped that these findings can bring some understanding to any correlations between pause location and listener ratings.

Listener Rating Correlations

The fourth research aim of this study was to examine the possible correlation between the listener ratings of communicative effectiveness and likeability significant? As expected, there was a strong positive correlation between the listener ratings of communicative effectiveness and likeability. Thus, as listeners rated effectiveness higher, they also rated likeability to a similar degree. This association may be due to the possibility that a listener favors a speaker more if the speaker is able to communicate his or her message in a clear, effective manner. This would be expected as research suggests that listeners more favorably rate the personal attributes of a speaker when these listeners do not feel like they have to expend much effort in listening to the speaker (Harmon et al., 2016).

One limitation of the current study was that participants were asked to simultaneously rate the communicative effectiveness and speaker likeability of a sample. As such, this study cannot rule out the possibility that the listeners did not cognitively separate the two ratings. Future studies should test these ratings separately rather than simultaneously to prevent any threats to internal validity.

Limitations

As has been previously mentioned, more data should be collected from typical speakers to accurately determine how the patterns of pause with PWA differ from typical patterns. Future studies could also look at how semantic factors, such as frequent vs. infrequent words, varying parts of speech, and morphologically complex words might influence the occurrence of extended pauses. Future studies could also examine how syntactic factors, including simple and more complex syntactic structures, influence the occurrence of extended pauses as well. In addition, it would be interesting to look at additional speakers with higher degrees of aphasia severity, as this study associated speech samples from six PWA, all with mild or moderate severity. It would also be interesting to analyze the acoustic measures and the listener ratings of speakers with Broca's aphasia without apraxia of speech to determine how the results of this study may compare. Lastly, the research paradigm used in this study may have been a limitation, as it was one in which all of the tokens were randomized in one block of which the listeners were asked to assign a rating from 0-100. Therefore, the listeners were not able to make comparisons of the speech samples as they were not provided with a model or anchor. As such, it may be of value to use a paired stimulus design where the listeners are presented with a model recording and are then asked to compare an utterance from a PWA.

Conclusions

Despite the limitations of this study and the need for future research, it is hoped that these findings will provide additional insight into how extended pauses might affect communication for PWA. As extended pauses are prevalent in the speech of PWA due to a variety of difficulties, it is significant to note that the location and length of pauses included in their speech do have an impact on listener perceptions. It is hoped that greater understanding in this area might improve future assessment and treatment of aphasia.

References

Aaronson, D. (1968). Temporal course of perception in an immediate recall task. *Journal of Experimental Psychology, 76*(1), 129-140. https://doi.org/10.1037/h0025290

Allard, E. R., & Williams, D. F. (2008). Listeners' perceptions of speech and language disorders. *Journal of Communication Disorders, 41*(2), 108-123. https://doi.org/10.1016/j.jcomdis.2007.05.002

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

Ash, S., McMillan, C., Gross, R. G., Cook, P., Gunawardena, D., Morgan, B., Boller, A., Siderowf, A., & Grossman, M. (2012). Impairments of speech fluency in Lewy Body Spectrum disorder. *Brain and Language, 120*(3), 290-302. https://doi.org/10.1016/j.bandl.2011.09.004

Barnett, C., Green, J. R., Marzouqah, R., Stipancic K. L., Berry, J. D., Korngut, L., Genge, A., Shoesmith, C., Briemberg, H., Abrahao, A., Kalra, S., Zinman, L., & Yunusova, Y. (2020.) Reliability and validity of speech & pause measures during passing reading in ALS. *Amyotrophic Lateral Sclerosis and Frontotemporal Degeneration, 21*(1-2), 42-50. https://doi.org/10.1080/21678421.2019.1697888

Baylor, C., Burns, M., Eadie, T., Britton, D., & Yorkston, K. (2011). A qualitative study of interference with communicative participation across communication disorders in adults. *American Journal of Speech-Language Pathology, 20*(4), 269-287. https://doi.org/10.1044/1058-0360(2011/10-0084)

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%2F002383097902200301

Boersma, P., & Weenink, D. (2021). *Doing phonetics by computer* (Version 6.1.40) [Computer program]. Praat. Retrieved 10 March 2021 from http://www.praat.org/

Bosker, H. R., Pinget, A., Quené, H., Sanders, T., & de Jong N. H. (2012). What makes speech sound fluent? The contributions of pauses, speed and repair. *Language Testing, 30*(2), 159-175. doi: 10.1177/0265532212455394

Cahana-Amitay, D., Albert, M. L., Pyun S.-B., Westwood, A., Jenkins, T., Wolford, S., & Finley, M. (2011). Language as a stressor in in aphasia. *Aphasiology, 25*(5), 593-614. https://doi.org/10.1080/02687038.2010.541469

Cahana-Amitay, D., Oveis, A. C., Sayers, J. T., Pineles, S. L., Spiro, A., & Albert, M. L. (2015). Biomarkers of "Linguistic Anxiety" in aphasia: A proof-of-concept case study. *Clinical Linguistics & Phonetics, 29*(5), 401-413. https://doi.org/10.3109/02699206.2015.1014572

Croteau, C., & Le Dorze, G. (2001). Spouses' perception of persons with aphasia. *Aphasiology, 15*(9), 811-825. doi: 10.1080/02687040143000221

Dalemans, R. J. P., de Witte, L., Wade, D., & van de Heuvel, W. (2010). Social participation through the eyes of people with aphasia. *International Journal of Communication Disorders, 45*(5), 537-550. https://doi.org/10.3109/13682820903223633

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. doi: 10.1044/2019_ajslp-cac48-18-0210

Esposito, A. (2005). Children's organization of discourse structure through pausing means. In M. Faundez-Zanuy, L. Janer, A. Esposito, A. Satue-Villar, J. Roure, & V. Espinsosa-Duro (Eds.), *Nonlinear analyses and algorithms for speech processing* (pp. 108-115). Springer-Verlag Berlin Heidelberg.

Esposito, A., Stejskal, V., Smékal, Z., & Bourbakis, N. (2007). The significance of empty speech pauses: Cognitive and algorithmic issues. In F. Mele, G. Ramella, S. Santillo, & F. Ventriglia (Eds.), *Advances in brain, vision, and artificial intelligence* (pp. 542-554). Springer-Verlag Berlin Heidelberg.

Goldman-Eisler, F. (1958). Speech production and the predictability of words in context. *Quarterly Journal of Experimental Psychology, 10*(2), 96-106. https://doi.org/10.1080%2F17470215808416261

Goodglass, H., & Kaplan, E. (1972). *The Boston Diagnostic Aphasia Examination.* Philadelphia, PA: Lea & Febiger.

Green, J. R., Beukelman, D. R., & Ball, L. J. (2004). Algorithmic estimation of pauses in extended speech samples of dysarthric and typical speech. *Journal of Medical Speech-Language Pathology, 12*(4), 149-154.

Greene, J. O. (1984). Speech preparation processes and verbal fluency. *Human Communication Research, 11*(1), 61-84. https://doi.org/10.1111/j.1468-2958.1984.tb00038.x

Greene, J. O., & Lindsey, A. E. (1989). Encoding processes in the production of multiple-goal messages. *Human Communication Research, 16*(1), 120-140. https://doi.org/10.1111/j.1468-2958.1989.tb00207.x

Harmon, T. G. (2018). *Communication partner attitudes, social and cognitive challenge, and spoken language in aphasia (Publication No. 10785796) [Doctoral dissertation,* University of North Carolina at Chapel Hill]. ProQuest Dissertations and Theses Global. https://doi.org/10.17615/km5x-0f35

Harmon, T. G., Jacks, A., Haley, K. L., & Bailliard, A. (2019). Dual-task effects on story retell for participants with moderate, mild, or no aphasia: Quantitative and qualitative findings. *Journal of Speech, Language, and Hearing Research, 62*(6), 1890-1905. https://doi.org/10/1044/2019_JSLHR-L-18-0399

Harmon, T. G., Jacks, A., Haley, K. L., & Bailliard, A. (2020). How responsiveness from a communication partner affects story retell in aphasia: Quantitative and qualitative findings. *American Journal of Speech-Language Pathology, 29*(1), 142-156. https://doi.org/10.1044/2019_AJSLP-19-0091

Harmon, T. G., Jacks, A., Haley, K. L., & Faldowski, R. A. (2016). Listener perceptions of simulated fluent speech in nonfluent aphasia. *Aphasiology, 30*(8), 922-942. doi: 10.1080/02687038.2015.1077925

Higginbotham, J., Drazek, A., Kowarsky, K., Scally, C., & Segal, E. (1994). Discourse comprehension of synthetic speech delivered at normal and slow presentation rates. *Augmentative and Alternative Communication, 10*(3), 191-202. https://doi.org/ 10.1080/07434619412331276900

Hird, K., & Kirsner, K. (2010). Objective measurement of fluency in natural language production: A dynamic systems approach. *Journal of Neurolinguistics*, *23*(5), 518–530. https://doi.org/10.1016/j.jneuroling.2010.03.001

Kertesz, A. (2006). *Western Aphasia Battery – Revised.* San Antonio, TX: Harcourt Assessment.

Laures-Gore, J. S., Dubay, M. F., Duff, M. C., & Buchanan, T. W. (2010). Identifying behavioral measures of stress in individuals with aphasia. *Journal of Speech, Language, and Hearing Research, 53*(5), 1394-1400. https://doi.org/10.1044/1092-4388(2010/09-0236)

Lee, J., Huber, J., Jenkins, J., & Fredrick, J. (2019). Language planning and pauses in story retell: Evidence from aging and Parkinson's disease. *Journal of Communication Disorders, 79*, 1-10. https://doi.org/10.1016/j.jcomdis.2019.02.004

Lennon, P. (1990). Investigating fluency in EFL: A quantitative approach. *Language Learning, 40*(3), 387-417. https://doi.org/10.1111/j.1467-1770.1990.tb00669.x

Mack, J. E., Chandler, S. D., Meltzer-Asscher, A., Rogalski, E., Weintraub, S., Mesulam 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

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

Murray, L. L. (2000). The effects of varying attentional demands on the word retrieval skills of adults with aphasia, right hemisphere brain damage, or no brain damage. *Brain and Language, 72*(1), 40-72. https://doi.org/10.1006/brln.1999.2281

O'Connell, D. C., Kowal, S., & Hörmann, H. (1969). Semantic determinants of pauses. *Psychologische Forschung, 33*, 50-67.

Peach, R. K. (2013). The cognitive basis for sentence planning difficulties in discourse after traumatic brain injury. *American Journal of Speech-Language Pathology, 22*(2), S285-S297. https://doi.org/10.1044/1058-0360(2013/12-0081)

Ratcliff, A., Coughlin, S., & Lehman, M. (2002). Factors influencing ratings of speech naturalness in augmentative and alternative communication. *Augmentative and Alternative Communication, 18*(1), 11-19. https://doi.org/10.1080/aac.18.1.11.19

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

Rong, P., Yunusova, Y., Wang, J., Zinman, L., Pattee, G. L., Berry, J. D., Perry, B., & Green, J. R. (2016). Predicting speech intelligibility decline in amyotrophic lateral sclerosis based on the deterioration of individual speech subsystems. *PLoS ONE, 11*(5). https://doi.org/10.1371/journal.pone.0154971

Shriberg, L. D., Strand, E. A., Fourakis, M., Jakielski, K. J., Hall, S. D., Karlsson, H. B., Mabie, H. L., McSweeny, J. L., Tilkens, C. M., & Wilson, D. L. (2017a). A diagnostic marker to discriminate childhood apraxia of speech from speech delay: II. Validity studies of the pause marker index. *Journal of Speech Language and Hearing Research*, *60*(4), S1118–S1134. https://doi.org/https://doi.org/10.1044/2016_JSLHR-S-15-0297

Shriberg, L. D., Strand, E. A., Fourakis, M., Jakielski, K. J., Hall, S. D., Karlsson, H. B., Mabie, H. L., McSweeny, J. L., Tilkens, C. M., & Wilson, D. L. (2017b). A diagnostic marker to discriminate childhood apraxia of speech from speech delay: I. Development and description of the pause marker. *Journal of Speech Language and Hearing Research*, *60*(4), S1096–S1117. https://doi.org/https://doi.org/10.1044/2016_JSLHR-S-15-0296

Smith, K. M., Ash, S., Xie, S. X., & Grossman, M. (2018). Evaluation of linguistic markers of word-finding difficulty and cognition in Parkinson's Disease. *Journal of Speech, Language, and Hearing Research, 61*(7), 1691-1699. https://doi.org/10.1044/2018_JSLHR-L-17-0304

Thomas, B. (2021). *Quantifying speech pause durations in speakers with nonfluent and fluent aphasia* [Unpublished master's thesis]. Brigham Young University.

Vojtech, J. M., Noordzij, J. P., Jr., Cler, G. J., & Stepp, C. E. (2019). The effects of modulating fundamental frequency and speech rate on the intelligibility, communication efficiency, and perceived naturalness of synthetic speech. *American Journal of Speech-Language Pathology, 28*(2S), 875-886. https://doi.org/10.1044/2019_AJSLP-MSC18-18-0052

Wilson, S. M., Eriksson, D. K., Schneck, S. M., & Lucanie, J. M. (2018). A quick aphasia battery for efficient, reliable, and multidimensional assessment of language function. *PLOS One, 13*(2). https://doi.org/10.1371/journal.pone.0192773

Wright, E. (2021). *The influence of pause on listeners' perceptions in speech of people with aphasia* [Unpublished master's thesis]. Brigham Young University.

Yorkston, K. M., Hammen, V. L., Beukelman, D. R., & Traynor, C. D. (1990). The effect of rate control on the intelligibility and naturalness of dysarthric speech. *Journal of Speech and Hearing Disorders, 55*(3), 550-560. https://doi.org/10.1044/jshd.5503.550

APPENDIX A

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 determine whether pause is distributed differently in the speech of individuals with aphasia compared to typical speakers. *Method:* Eighteen individuals (ages 40-74) who suffered a left hemisphere stroke and 19 typical adults (ages 45-86) participated in this study. Every individual spoke Greek as their primary language and was right-handed. Speech samples were collected from every individual, and the silent pauses of each speech sample were analyzed by ELAN. *Results:* A bimodal pattern of pause duration was observed in both populations, thus classifying pauses into short and long groups. There was a similar correlation between long pause rate and speech rate in both populations. The speech samples of the individuals with aphasia contained more pauses overall, had longer pauses within and between utterances, and had a higher median of long pauses than those of the control group. *Conclusions:* Long pauses provide individuals with aphasia with additional time to carry out cognitive linguistic processes such as word-finding or sentence planning. The pause patterns of individuals with aphasia mimic the pause patterns of individuals without aphasia; however, the large number and length of long pauses will cause these patterns to be impaired. *Relevance to Current Study:* This study provides insight into why individuals with aphasia include more pauses in their speech.

Baskett, G. D., & Freedle, R. O. (1974). Aspects of language pragmatics and the social perception of lying. *Journal of Psycholinguistic Research, 3*(2), 117-131. https://doi: 10.1007/BF01067571.

Objective: This study explored how linguistic and extralinguistic aspects of speech influence a listener's perception of a speaker. *Methods:* In Experiment 1, 83 students participated, and 2 tape recordings were made. On the first recording, the examiner read a personality-trait adjective, and the speaker would indicate if he possessed that personality trait (by indicating "true" or "false"). The examiner and speaker continued this procedure for 54 personality traits, and the speaker's true/false response was randomly selected each time. A randomly selected time delay (0.07, 0.20, 0.34, 0.74, 1.07, 2.07, 3.07, 4.07, & 6.07 seconds) was also selected to follow each adjective mentioned. The second recording contained this same material except the speaker gave the opposite response that he had given in the first recording. Thirty-nine participants listened to the first recording and 44 participants listened to the second recording. Each participant was asked to listen to each item and to respond whether they thought the speaker's response was a lie or not. In Experiment 2, a total of 71 students participated. Thirty-five participants were given the list of 54 personality traits used in Experiment 1 and was asked to give a number that described the percentage of the general population that exhibited this personality trait. 36 participants were given the list of 54 personality traits and were asked to provide a number that described the percentage of the general population that would use each personality trait to describe themselves. *Results:* In Experiment 1, both extremely short and long pauses before a response resulted in a listener's perception that the speaker was lying. The desirability of the personality trait combined with the speaker's response also

influenced whether a listener perceived the speaker to be lying. In Experiment 2, participants thought that a higher percentage of the population exhibited unfavorable traits and a lower percentage exhibited favorable traits than they believed that the general population would express about themselves. *Conclusions:* Very short and very long pauses before a response increase the likelihood that a listener will perceive a speaker to be lying. The social desirability of a particular personality trait combined with a speaker's answer also contributes to a listener's perception of lying (e.g., the likelihood of a speaker lying increases when he/she responds "true" to a less favorable adjective or "false" to a more favorable adjective). There is a higher likelihood overall that the listener will perceive that the speaker is lying when he responds "false", despite the time delay or desirability of the personality trait. Listeners are more willing to label others with less favorable personality traits than themselves. *Relevance to Current Study:* This study examines how time delays before a speaker's response affect a listener's perception of the speaker.

Bosker, H. R., Pinget, A., Quené, H., Sanders, T., & de Jong N. H. (2012). What makes speech sound fluent? The contributions of pauses, speed and repair. *Language Testing, 30*(2), 159-175. doi: 10.1177/0265532212455394

Objective: To explore the relationship between pause, speech rate, and speech repairs on perceived speech fluency. *Methods:* Eighty Dutch-speaking natives participated in 4 different experiments for this study. In Experiment 1, 20 participants listened to speech samples and rated overall speech fluency based on the number of pauses, the rate of speech, and the number of hesitations/corrections. In Experiment 2, 20 participants were asked to listen and rate the same speech samples used in Experiment 1 according to the number of pauses. Experiment 3 used the same stimuli as in the experiments above and asked 20 participants to listen and rate the speech samples according to the speech rate. Experiment 4 used the same stimuli presented as in the experiments above and asked 20 participants to listen and rate the speech samples according to the number of hesitations/corrections. Every individual then participated in a post-experimental questionnaire. *Results:* The participants of this study claimed that they were influenced most by the number of pauses and the speech rate when rating the fluency of a speech sample. Pause ratings were observed to have a larger R^2 value than any of the other measures. *Conclusions:* A listener's perception of fluency is primarily determined by the number and duration of silent pauses. *Relevance to Current Study:* This study discusses the role that pauses play in a listener's perception of speech.

Brennan, S. E., & Williams, M. (1995). The feeling of another's knowing: Prosody and filled pauses as cues to listeners about the metacognitive states of speakers. *Journal of Memory and Language, 34*(3), 383-398. https://doi.org/10.1006/jmla.1995.1017

Objective: To determine how filled and unfilled pauses affected a listener's judgement of a speaking knowing an answer to a question. *Methods:* Three different experiments were conducted in this study. In Experiment 1, 14 students participated. The examiner faced away from the participant and asked him/her a question, and the participant responded to the question. The participant's responses were recorded, transcribed, and analyzed. The examiner did not tell the participant if he/she correctly answered the question. After 20 questions had been asked, the participant filled out a questionnaire that asked the participant to rate (scale of 1-7) whether he/she would recognize the answer to each of the 20 questions if given a multiple-choice test. The participant then took a multiple-

choice test of the previous 20 questions. In Experiment 2, 48 individuals participated. The participants were asked to listen to 60 question and answers (from Experiment 1) and rate “how likely it was that the listener knew the correct answer”. If the recorded person did not provide an answer to the question, the listener was asked to rate how likely the recorded person would be able to identify the correct answer to the question when given a multiple-choice test. In Experiment 3, 72 participants were included. The procedure was the same as the procedure in Experiment 2. However, the material presented differed in that researchers systematically inserted a short unfilled pause (1 second), a long unfilled pause (5 seconds), an unfilled pause followed by “um” (5 seconds total), or an unfilled paused followed by “uh” (5 seconds total) before each answer or “nonanswer”. *Results:* In Experiment 1, the questionnaire contained higher ratings for questions that the participants were able to answer compared to those that they couldn’t answer. The questionnaire also contained higher ratings for the questions that the participants answered more quickly. If a participant could not produce an answer but thought about the question for a while, the questionnaire contained higher ratings. The questionnaire contained lower ratings for participant answers that contained filled pauses compared to unfilled pauses. In Experiment 2, listeners provided higher ratings when answers were provided to questions compared to when answers were not provided. When answers were provided, listener ratings were determined by the latency time and the individuals’ intonation. Specifically, ratings were about 1 point higher when answers were given after a short pause compared to a long pause. When answers were not provided, listener ratings were determined by the latency time and the “nonanswer” that was given. Specifically, listeners ratings were slightly higher when the “nonanswer” was provided after a long pause compared to a short pause. In Experiment 3, listener ratings were 1.91 points higher for answers provided than "nonanswers." Listener ratings were 1.59 points higher for answers provided after a 1 second pause compared to those given after a 5 second pause. Listener ratings for filled 5-second pauses (um, uh) were .52 points lower than then unfilled 5 second pauses. For "nonanswers," listener ratings were .39 points higher for 5 second pauses overall. Listener ratings were .31 point higher for filled 5 second pauses before "nonanswers" than unfilled 5 second pauses. *Conclusions:* The quicker an answer is given to a question, the more likely a listener will believe that the answer was correct. The longer the pause in between a question and an "nonanswer," the more likely a listener will believe that a speaker would be able to recognize the correct answer on a multiple-choice test. Answers provided before a filler word are less likely to be rated as a correct answer than those given before unfilled pauses. "Nonanswers" provided before a filler word are more likely to be rated as a correct answer than those given before unfilled pauses. This may suggest that filled pauses are perceived as an active attempt to answer a question, while unfilled pauses before "nonanswers" are perceived as the lack of desire to try. *Relevance to Current Study:* This study examined the perceptual judgements of filled and unfilled pauses between a question and response.

Croteau, C. & Le Dorze, G. (2001). Spouses' perception of persons with aphasia. *Aphasiology, 15*(9), 811-825. doi: 10.1080/02687040143000221

Objective: This study explored whether people with aphasia are perceived differently by their spouses compared to how typical speakers are perceived by their spouses. *Methods:* Twenty-one spouses of people with aphasia and 25 spouses of neurotypical adults participated in this study. The participants were matched for age, level of education, work, and the language spoken. The people with aphasia were at least one-year post-onset, and the group included many different aphasia types and severities. Researchers used the Functional Status Index to measure the functional ability of the people with aphasia. The Adjective Check List was then given to the spouses of people with and without aphasia to collect their perceptions of their partner on scales of likeability, achievement, endurance, order, and succorance. A likeability index was calculated from the results. *Results:* The people with aphasia received lower likeability scores from their spouses than the typical adults. The wives of men with aphasia perceived their husbands to be working less in obtaining significant achievements than the wives of men without aphasia. The wives of men with aphasia perceived their husbands to be less persistent than the wives of men without aphasia. The people with aphasia received lower scores of organization and neatness by their spouses than neurotypical adults. According to their spouses, the people with aphasia were considered to receive more sympathy and support from others than the people without aphasia. *Conclusions:* People with aphasia are perceived differently by their spouses than people without aphasia. Women with aphasia were perceived differently by their spouses than men with aphasia. *Relevance to Current Study:* This study provides evidence that people with aphasia are perceived differently than people without aphasia.

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. doi: 10.1044/2019_ajslp-cac48-18-0210

Objective: To discover whether temporal measures of discourse differed between individuals with latent aphasia (who exhibit “subtle language difficulties”), individuals with anomic aphasia, and typical individuals. *Methods:* Thirty total participants were included in this study. Ten participants had latent aphasia, ten participants had anomic aphasia, and ten participants were neurotypical. Each group was matched according to age, level of education, and gender. The individuals with latent or anomic aphasia were matched according to the time of their stroke onset. Every individual participated in the AphasiaBank Protocol and was therefore asked to participate in the Cinderella narrative task. Each participant's narrative was transcribed, and the speech temporal measures (articulation rate, pure word rate, speech rate, and silent pause duration [≥ 200 ms]) were analyzed. Articulation rate involves word time duration and dysfluencies (except silent pauses). Speech rate includes silent pause duration and all other dysfluencies. *Results:* The neurotypical individuals produced shorter silent pauses than the individuals with latent or anomic aphasia. The neurotypical individuals also had a higher speech rate than the individuals with latent or anomic aphasia. The group with anomic aphasia exhibited a slower articulation grate compared to the neurotypical and latent aphasia groups. *Conclusions:* Individuals with latent or anomic aphasia have more difficulty with lexical retrieval in narratives than neurotypical adults. The reduced articulation rate in the group with anomic aphasia suggests that they had more filled pauses in their speech. The slower speech rate and long pause duration in the latent aphasia group, in particular, suggests that individuals with latent aphasia have difficulty in processing speed and language planning. *Relevance to Current Study:* Silent pause duration differs in the speech of individuals with aphasia compared to neurotypical individuals. This difference may be indicative of lexical retrieval, processing speed, or language planning difficulties.

Deloche, G. (1979). Study of the temporal variables in the spontaneous speech of five aphasic patients in two situations, interview and description. *Brain and Language, 8*(2), 241-250. https://doi.org/10.1016/0093-934X(79)90052-X

Objective: The purpose of this study was to determine the roles that the number of pauses, the mean duration of pauses, and the phonation rate play on the verbal rate of an individual's speech. *Methods:* Five patients with aphasia and one typical speaker participated in this study. Each individual participated in a 5-minute interview task and a 5-minute description task. In the interview task, the participants were asked to talk about whatever they liked with the interviewer. In the description task, the participants were asked to describe a black and white picture. The participants' speech samples were then analyzed for the verbal rate (# of syllables/min of locution), the phonation rate (# of syllables/second of articulation), the total number of pauses, and the mean duration of pauses (in seconds). *Results:* Normal subject experienced an increase in pause time and a slight increase in the number of pauses in the picture description task. The patient with Broca's aphasia had the slowest verbal rate in both tasks than any of the other patients, due to the increased mean pause duration in the patient's speech. The patient with anomic aphasia had a slower verbal rate than the other participants, due to the increased mean pause duration of the patient's speech. *Conclusions:* A picture description task is of greater linguistic difficulty than free conversation, and therefore, typical individuals will include an increased number of pauses of increased length in this task. The mean duration of pauses plays a huge role in the verbal rate of individuals with aphasia and is considered more important in pause time than the total number of pauses. These results suggest that the increase in mean pause duration of the speech of individuals with aphasia

may be due to an impairment in the "mechanisms of evocation". *Relevance to Current Study:* Pause duration plays an important role in determining the verbal rate of individuals with aphasia.

Esposito, A. (2005). Children's organization of discourse structure through pausing means. In M. Faundez-Zanuy, L. Janer, A. Esposito, A. Satue-Villar, J. Roure, & V. Espinsosa-Duro (Eds.), *Nonlinear analyses and algorithms for speech processing* (pp. 108-115). Springer-Verlag Berlin Heidelberg.

Objective: This study investigated the different pausing strategies children use in their speech. *Methods:* Fourteen Italian native children participated in this study. Ten of the participants were female, and 4 of the participants were male. Each participant participated in a narrative task where they watched an animated cartoon and were asked to relate the cartoon's story to a group of listeners. Each participant's narrative was recorded and analyzed for the presence of empty pauses, filled pauses, and phoneme lengthening. Short empty pauses were classified as silence from 0.150-0.500 seconds long, medium empty pauses from 0.501-0.900 seconds long, and long empty pauses as more than 0.900 seconds long. *Results:* Overall, short pauses occurred 33% of the time, medium pauses occurred 10% of the time, and long pauses occurred 6% of the time in the children's speech. Empty pauses occurred more frequently than filled pauses and phoneme lengthening in both the male and female participants. Besides a few exceptions (4% of short pauses and 3% of medium pauses for females and 6% of short pauses for males), the participants used pauses to contribute new information to a listener's understanding of a narrative. Ninety-six percent of long pauses and 81% of medium pauses in the speech of female participants were connected to a change of scene, time,

and event structure. Ninety-four percent of long pauses and 33% of medium pauses in the speech of male participants were affiliated with a change of scene, time, and event. Twenty percent of short pauses in females and 8% of short pauses in males were affiliated with a change of scene, time, and event. *Conclusions:* Short, medium, and long pauses have different responsibilities in structuring discourse. Longer pause time is required for higher levels of cognitive load or effort, as greater time is needed to retrieve new information from memory and/or to signal a change in scene, time, or event. There is a low probability that children will use short pauses to change the scene, time, or event of a narrative; therefore, children rarely use short pauses to signal paragraph boundaries. *Relevance to Current Study:* This study demonstrates the different roles that short, medium, and long pauses play in the narratives produced by children.

Esposito, A., Stejskal, V., Smékal, Z., & Bourbakis, N. (2007). The significance of empty speech pauses: Cognitive and algorithmic issues. In F. Mele, G. Ramella, S. Santillo, & F. Ventriglia (Eds.), *Advances in brain, vision, and artificial intelligence* (pp. 542-554). Springer-Verlag Berlin Heidelberg.

Objective: This study investigated the different pausing strategies children and adults use in their speech. *Methods:* Ten Italian-speaking natives participated in this study. Eight of these participants were children (4 male and 4 female), and four of them were adults (2 male and 2 female). Each participant participated in a narrative task where they watched an animated cartoon and were asked to relate the cartoon's story to a group of listeners. Each participant's narrative was recorded and analyzed for the presence of empty pauses and disfluencies. Empty pauses were considered to be silences 120 milliseconds or longer. Disfluencies included filled pauses, interruption, and phoneme lengthening.

Results: In the group of children, the female participants had a higher empty pause rate than the male participants. Both the male and females in the children's group had a higher empty pause rate than adults. Male children used an empty pause to mark 73% of clause boundaries, female children used an empty pause to mark 70% of clause boundaries, and adults used an empty pause to mark 56% of clause boundaries. Male children used an empty pause to mark 96% of paragraph boundaries, female children used an empty pause to mark 97% of paragraph boundaries, and adults used an empty pause to mark 94% of paragraph boundaries. Ninety-one percent of empty pauses in male children, 84% of empty pauses in female children, and 95% of empty pauses in adults were used to provide added information (any words or sentences that cause a "modification in the listener's conscious knowledge"). *Conclusions:* Children and adults both use empty pauses to signal clause and paragraph boundaries. Both children and adults use empty pauses as a strategy to retrieve new information they are attempting to express from their memories. *Relevance to Current Study:* Typical children and adults use pause to signal discourse boundaries. They also use pause to give them time to retrieve the information they wish to express.

Goldman-Eisler, F. (1958). Speech production and the predictability of words in context. *Quarterly Journal of Experimental Psychology, 10(2)*, 96-106. https://doi.org/10.1080%2F17470215808416261

Objective: The purpose of this study was to discover if pauses indicate an increase of information in speech. *Methods:* Six subjects participated in Experiment 1 and Experiment 2. In Experiment 1, each subject was provided with some context about a particular topic. Each participant was then given 1 minute to guess each word in a target

sentence pertaining to the topic (starting with the first word). If the participant was unable to guess a target word within the time constraint, he or she was given the target word, and the participant proceeded to guess the next word in the sentence. Each subject participated in this procedure for a total of 7 sentences. In Experiment 2, each subject was provided with some context about a particular topic. Each subject was then given 1 minute to guess each word in a target sentence pertaining to the topic. Three subjects began guessing with the first word in the sentence, and three subjects began guessing with the last word in the sentence. If the participant was unable to guess the word within the time constraint, he or she was given the target word, and the participant proceeded to guess the next word (working forwards or backwards) in the sentence. Each subject participated in this procedure for a total of 6 sentences *Results:* In Experiment 1, the transition probability for words preceding pauses was more than the transition probability for words following pauses. Twenty-five out of two hundred and five of the words in the treatment sentences had a transition probability of 0 (indicating that they were very unpredictable), and sixteen out of those twenty-five words were preceded by a pause. Most of the pauses had decreased transition probabilities. In Experiment 2, 58% of words were predicted in the forward guessing of a sentence, and 53% of the words were predicted in the backward guessing of a sentence. Fourteen percent of the 136 words in the sentences were very unpredictable, and most of them followed a pause. The words produced after pauses remained very unpredictable in both forward and backward guessing. The 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. *Conclusions:* Pauses have the ability to indicate an increase in information in speech. Speech pauses are highly related to prediction uncertainty. Fluent speech most commonly consists of words that are habitually produced, while hesitant speech (speech with many pauses) is closely associated with words that are highly specific to a particular speaker. *Relevance to Current Study:* This study examines the relationship between pausing and transitional probability. Pauses tend to be found before unpredictable words.

Greene, J. O. (1984). Speech preparation processes and verbal fluency. *Human Communication Research, 11*(1), 61-84. https://doi.org/10.1111/j.1468-2958.1984.tb00038.x

Objective: This study further explored the action assembly theory. Researchers wanted to know whether having a prepared plan of action influenced speech fluency and if increased practice trials would decrease silent pausing. *Methods:* Experiment 1 included 40 males in its study. This study contained 2 experimental groups and 1 control group. Every participant was provided with 3 sets of factual information, and they were informed that they would be tested on the given information. Every participant was then provided with a list of steps to study. The experimental groups were given an "four-step organizational sequence" for oral presentations, and the control group was provided with a "four-step sequence for asking" interview questions. Each participant then filled out a survey designed to test the participant's knowledge of the factual information. Afterwards, every participant was instructed to persuasively dispute in favor of a particular topic. The participants in the experimental groups were also told to use the "four-step" organizational sequence in their presentation. Silent pauses (of 250 ms or longer) and filled pauses were analyzed in each participant's presentation. Experiment 2

included 32 females, and each participant was randomly assigned to either a control group, a one practice-trial group, or a two-practice-trials group. Every participant was provided with 4 sets of factual information. Every participant was then provided with a list of steps to study. The control group was provided with 4 steps for receiving information in employment interviews, and the experimental groups were provided with a "four-step solution-problem sequence." Every participant was then required to read an essay of an unrelated subject. The participants in the experimental groups were asked to discuss 1 or 2 topics from the essay (depending on which experimental group they were in) using the 4-step sequence they had previously studied. Each participant was then instructed to persuasively dispute in favor of a particular topic. The participants in the experimental groups were also told to use the "four-step" organizational sequence in their presentation. Silent pauses were analyzed in the speech of each participant. *Results:* In Experiment 1, the speech of the subjects in the experimental groups contained lower silent pause ratios and less silent pauses than the speech of those in the control group. In Experiment 2, those who were given 2 practice trials had the least mean pause ratio. *Conclusions:* Additional practice (or trials) with an "organizing" sequence will lead to a decrease in the number of silent pauses contained in a person's speech. Speech or verbal output preparation increases speech fluency; therefore, it decreases the number of silent pauses in a person's speech. Having an "abstract plan of action" before speaking will reduce one's cognitive load (thus reducing the number of pauses in an individual's speech) compared to an individual who must come up with his/her plan of action as he/she speaks. *Relevance to Current Study:* This study discusses how preparation and cognitive processes are related to silent pauses.

Greene, J. O., & Lindsey, A. E. (1989). Encoding processes in the production of multiple-goal messages. *Human Communication Research, 16*(1), 120-140. https://doi.org/10.1111/j.1468-2958.1989.tb00207.x

Objective: The aim of this study was to discover if having multiple social goals would increase one's cognitive load. *Methods:* Forty-nine males and 37 females were included in this study. Each participant was randomly placed into 1 of 4 groups (single social goal with spontaneous message preparation, single social goal with advanced message preparation, multiple social goals with spontaneous message preparation, or multiple social goals with advanced message preparation). In the study's first stage, researchers gathered baseline data by asking each participant to spontaneously speak about a particular topic. In the study's second stage, each participant was provided with a file of scholarship applicant information and was asked to take a couple minutes to study the file's contents. Subsequently, the participants were informed that they would speak on another specific topic. The participants who were assigned to the spontaneous message preparation groups were asked to read the topic aloud and to then talk about that specific topic. The participants assigned to the advanced message preparation groups were asked to read the topic aloud, to take 60 seconds to prepare their message, and to present their message after these 60 seconds. In addition, the participants in the single goal group were told that they would not be addressing the scholarship applicant directly, so they could be direct in their opinions. The participants in the multiple goals group were told that they would also be addressing the scholarship applicant, so they should also take the applicant's thoughts and feelings into account. Speech-onset latency (the period after the participant finished reading the instructions/topic and started talking) and silent pauses

(250 ms or longer) were analyzed in each participant's speech. At the end of this experiment, the participants completed an inventory and attended a debrief meeting. *Results:* Researchers found longer speech-onset latencies for the participants that were asked to spontaneously give their message. However, the participants who were given advanced preparation only paused slightly less than those who were asked to spontaneously present their message. The participants in the multiple goal groups had longer speech-onset latencies overall than those in the single goal groups. The participants who had a single goal paused less than those who had multiple goals. The participants given advanced preparation did not include as many long pauses (1.5 seconds or greater) in their speech as those who were required to spontaneously produce their message. *Conclusions:* Multiple social goals require a greater cognitive load and thus more pauses and more pausing time in an individual's speech. Advanced preparation reduces the cognitive load on an individual (in both the single goal and multiple goal conditions); therefore, the initiation of their speech will require less pausing time. However, advanced preparation had little effect on the number of pauses included in an individual's speech once he/she began talking. This suggests that individuals use advanced preparation time to think about the overall message they desire to give, however, they are still required to assemble and produce their message in real-time. Those who are given advanced preparation, however, will have fewer long pauses in their speech than those who are not given this preparation. *Relevance to Current Study:* This study shows that pauses do reflect an individual's cognitive load.

Harmon, T. G., Jacks, A., & Haley, K. L. (2019). Speech fluency in acquired apraxia of speech during narrative discourse: Group comparisons and dual-task effects. *American Journal* *of Speech-Language Pathology, 28*(5), 905-914. https://doi.org/10.1044/2018_AJSLP-MSC18-18-0107

Objective: To determine if speech fluency differed between individuals with aphasia only and individuals with both aphasia and apraxia, and to determine if an increased cognitive load decreased the speech fluency of an individual with aphasia. *Methods:* Seven individuals with aphasia only, seven individuals with aphasia and apraxia, and seven controls participated in this study. These participants performed in two narrative retell tasks: one by itself and another while differentiating between two tones. These narratives were analyzed according to four characteristics of speech fluency: sample duration, pause/fill time, speech rate, and repetitions per syllable. *Results:* Individuals with aphasia only and individuals with aphasia and apraxia spoke at a slower rate and included more pauses than individuals without aphasia. About half of almost every narrative sample of individuals with aphasia consisted of pauses/fillers. The individuals with both aphasia and apraxia produced longer samples and included more repetitions in their samples than the control group. Every group had an increase in pause/fill time when asked to retell a story while discriminating between two tones, but the control group was the only group that spoke slower during that task. There wasn't a group that changed the length of the narrative or the number of repetitions when asked to retell a story while differentiating between two tones. *Conclusions:* The speech of individuals with aphasia has more disfluencies than the speech of individuals without aphasia. Fluency decreases in people with and without aphasia as the cognitive load increases. *Relevance to Current Study:* This study demonstrates the relationship between cognitive pause and aphasia with and without an increased cognitive load in narratives.

Harmon, T. G., Jacks, A., Haley, K. L., & Faldowski, R. A. (2016). Listener perceptions of simulated fluent speech in nonfluent aphasia. *Aphasiology, 30*(8), 922-942. doi: 10.1080/02687038.2015.1077925

Objective: This study compared listener perceptions of people with aphasia to listener perceptions of neurotypical speakers. The study also examined the effects of simulated speech fluency on listener perceptions of speakers with aphasia. *Methods:* Thirty-six adult listeners participated in this study. Eighteen of these listeners were undergraduates from a variety of majors, and eighteen of them were speech-language pathologist graduate students. Researchers obtained 9 audio samples from the AphasiaBank database to use in the study. 6 of these audio samples were produced by people with aphasia, and 3 of them were produced by neurotypical adults. The people with aphasia included in the 6 audio samples had a Western Aphasia Battry (WAB) classification of Broca's aphasia, a WAB aphasia quotient greater than 40, and had received a score of 5 or greater on the Boston Naming Test. Each of the 6 aphasic audio samples were copied and altered to create a fluent audio sample by deleting silent pauses greater than 0.4 seconds, fillers filled pauses, repetitions, and revisions. The researchers left all other aphasic behaviors in the audio sample. Listeners were asked to rate 9 audio samples (3 unaltered aphasic samples, 3 simulated aphasic samples, and 3 neurotypical samples). The unaltered and altered aphasic audio samples were placed in 2 separate groups (A or B) to prevent a listener from listening to the same speaker's unaltered and altered audio sample. Listeners were not informed about the editing of the aphasic audio samples. Listening sessions occurred individually for 12 of the listeners and in groups of 2-6 people for 24 of the listeners. The listening sessions were randomly assigned to sample group A or B, and the audio samples were presented in a randomized order. After listening to an audio sample, listeners were asked to rate 9 statements about the speaker's speech, the speaker's attributes, and their own feelings about the audio sample on a 7-point Likert scale. Listener ratings were analyzed with a mixed effects ANOVA. *Results:* Researchers found a statistical difference between the aphasia and fluency factors, as the altered aphasic audio samples were rated more favorably than the unaltered audio samples. Researchers also found a statistical difference between aphasia and speech output ratings, as the aphasic audio samples were rated less favorably for ease of storytelling and speech intelligibility than the neurotypical audio samples. The simulated aphasic audio samples were rated higher than the non-simulated samples in regard to the ease of storytelling but not regarding speech intelligibility. Listeners perceived the people with aphasia to be less intelligent, less confident, less competent, and less friendly than the neurotypical adults. Listeners perceived the simulated audio samples to be more intelligent, more confident, more competent, and more friendly than the unaltered aphasic audio samples. Listeners felt more comfortable, more patient, and felt like they expended less effort when listening to neurotypical speakers compared to people with aphasia. Listeners felt more comfortable, more patient, and felt like they expended less effort when listening to the simulated fluency samples compared to the unaltered aphasic audio samples. *Conclusions:* Overall, neurotypical audio samples were rated more favorably than the aphasic audio samples. The simulated fluency samples were rated more favorably than the unaltered aphasic audio samples. *Relevance to Current Study:* This study suggests that fluency does affect listener perceptions in people with nonfluent aphasia.

Kraut, R. E. (1978). Verbal and nonverbal cues in the perception of lying. *Journal of Personality and Social Psychology, 36*(4), 380-391. doi: 10.1037/0022-3514.36.4.380

Objective: The study aimed to explore when and how a listener determines that a speaker is lying. *Methods:* Two experiments were included in this study. In Experiment 1, 5 males participated in a simulated job interview. Each participant was informed that he should do all he could to appear sincere in the interview. A set of lights set behind the interviewer told each participant whether to lie or to tell the truth when the interviewer asked him a question. Each interview was recorded, and 12-18 observers judged the answers in each interview to determine if they were truths or lies. In Experiment 2, 74 individuals were asked to listen to a portion of a simulated interview. In the interview, the interviewee was asked to answer a question, and a 7-second pause or a 1-second pause was inserted before the interviewee's answer. The participants of the study were asked to relate whether the interviewee's answer was truthful or not and to rate their confidence in their answer. *Results:* The participants included shorter pauses and provided longer answers when telling the truth. The observers perceived the participants' answers to be true when they contained shorter pauses. The 7-second pause caused the listener to feel less confident in the truthfulness of the interviewee's answer if they were already suspicious about her honesty and if her answer would benefit her in some way. However, if the listener felt like the interviewee was being truthful and that an honest answer would not benefit the interviewee in any way, the 7-second pause caused the listener to further believe that the interviewee was honest. *Conclusions:* The results of Experiment 1 suggest listeners are more likely to believe an individual is telling the truth when shorter pauses are included before an individual's answer is given. The results of Experiment 2 demonstrated that pauses can signal underlying thought and speech processes. If a self-serving answer is followed by a long pause, a listener is more likely to perceive the answer as a lie. The pause is perceived as time to create the lie. If a self-damaging answer (one that might hurt one's reputation, etc.) is followed by a long pause, a listener is more likely to perceive the answer as truth. The pause is perceived as time for the individual to think about how he/she wants to say or phrase the answer. *Relevance to Current Study:* This study examines the perceptual judgments of pauses when included between a question and an answer.

Lay, C. H., & Burron, B. F. (1968). Perception of the personality of the hesitant speaker. *Perceptual and Motor Skills, 26*(3), 951-956. doi: 10.2466/pms.1968.26.3.951 *Objective:* The aim of this study was to explore how "hesitancy" affects one's perception of a speaker. This study also explores the relationship between "hesitancy" and the perceived emotional state of the speaker. *Methods:* Forty males and forty females were included in this study. A tape of "non-hesitant" speech and "hesitant" speech (characterized by filled pauses, unfilled pauses, and repetitions) was prepared. Each subject blindly listened to the speech of a "hesitant" or "non-hesitant" speaker and were asked to rate the speaker (from 1-9) on several trait characteristics. Fifteen of the characteristics were considered "desirable," 14 were considered "neutral," and 15 were considered "not desirable." Each of the subjects also rated the person as "anxious," "tense," and "nervous," as well as either "hesitant" or "fluent." *Results:* The hesitant speaker was perceived as more hesitant than the non-hesitant speaker. The "desirable" traits were rated as more typical of the "non-hesitant" speaker. *Conclusions:* A non-hesitant speaker is perceived as someone more desirable or favorable than a hesitant

speaker. Hesitancy in speech may be perceived as an undesirable characteristic. *Relevance to Current Study:* This study examines listeners' perceptions of filled pauses, unfilled pauses, and repetitions overall on one's personality.

Lee, J., Huber, J., Jenkins, J., & Fredrick, J. (2019). Language planning and pauses in story retell: Evidence from aging and Parkinson's disease. *Journal of Communication Disorders, 79*, 1-10. https://doi.org/10.1016/j.jcomdis.2019.02.004

Objective: To understand the relationship between pauses in connected speech and the cognitive processes required for the production of language in both aging and Parkinson's disease. *Methods:* Forty-nine people (15 young adults, 18 elderly adults, and 16 individuals with Parkinson's disease) participated in this study. Each participant participated in a story retell task, and each participant's narrative underwent a pause and linguistic analysis. *Results:* The younger group produced a mean of 26 pauses, the older group produced a mean of 36 pauses, and the group with Parkinson's produced a mean of 31 pauses in their narratives. There was not a group effect for pauses inserted at syntactic boundaries, but the older group inserted more pauses at abnormal linguistic locations than the younger group did. The syntactic pause index of older adults and those with Parkinson's disease is negatively correlated with their clause density measure. *Conclusions:* Parkinson's disease and aging do not impact the pauses inserted at typical syntactic locations during a narrative retell task. The insertion of pauses at abnormal linguistic locations are considered typical in aging adults, due to cognitive changes that take place as an individual ages. Many pauses inserted in the speech of older individuals and individuals with Parkinson's disease indicates that these individuals are not as efficient in producing language and will produce not as complex sentences. *Relevance to*

Current Study: Pauses do not have to reflect an underlying pathology, as they are also part of the aging process.

Mack, J. E., Chandler, S. D., Meltzer-Asscher, A., Rogalski, E., Weintraub, S., Mesulam 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 explore pause distribution in the narratives of patients with primary progressive aphasia and typical adults. This study also examined how pauses related to cortical atrophy. *Methods:* Three groups of participants with primary progressive aphasia (PPA) and 1 group of 12 typical participants were included in this study. The 3 groups of participants with PPA included 12 individuals with PPA-G (agrammatic variant), 11 individuals with PPA-L (logopenic PPA), and 12 individuals with PPA-S (semantic variant). Each individual was asked to produce the narrative of Cinderella. The individuals were provided with a wordless picture book to review the story beforehand, but it was removed before they started speaking. The individuals' narratives were then recorded, transcribed, and analyzed. Researchers also noted each individual's naming ability through the Northwestern Naming Battery. Structural MRI's were taken of the participants' brains. *Results:* The results of this study revealed that the individuals with PPA produced more pauses than the typical speakers. The participants with PPA-G produced more pauses compared to the other groups of individuals with PPA. The results also indicated that across groups, the participants with slower speech rates included more pauses in their speech. In addition, increased paused rates were noted for low-frequency words and for verbs. Compared to the other groups, the participants with PPA-L were

found to pause more often before nouns than verbs. Across the PPA participants, pause rate decreased as naming severity increased. Atrophy in the brain's left precentral gyrus, inferior frontal gyrus, and inferior parietal lobule was found in the participants who paused more often before nouns. Atrophy in the brain's left precentral and inferior parietal areas was found in the participants who paused more often before low frequency words, as well as words of increased length. *Conclusions:* Individuals with PPA have an increased number of pauses in their speech compared to typical individuals. Individuals with PPA-G have difficulties with the later stages of naming (phonological encoding and articulatory processes), thus resulting in a higher pause rate in their speech. Individuals with PPA-L have difficulties with lemma-level noun-retrieval, and therefore, they will pause more often before nouns than verbs. Due to the decreased number of pauses in the narratives of those with severe naming abilities, the results suggest that unique processes are involved in the word retrieval in narratives compared to the word retrieval in naming tasks. Atrophy of the brain's posterior inferior frontal gyrus may be responsible for noun retrieval deficits in the production of narratives. *Relevance to Current Study:* This study examines the pause characteristics of individuals with PPA and what that suggests for them.

O'Connell, D. C., Kowal, S., & Hörmann, H. (1969). Semantic determinants of pauses. *Psychologische Forschung, 33*, 50-67.

Objective: The aim of this study was to explore how semantics (while keeping syntax constant) affect pause rate and duration. *Methods:* This study included 40 native German-speaking participants. Each participant was asked to read two paragraphs (each consisting of 5 sentences of 23 syllables each) to the examiner. The third sentence in each of the

paragraphs described an event that was either in line with the story's plot or something that was highly unexpected. After the participant read each paragraph, he/she was asked to retell the story of each paragraph. Each of the participant's speech samples were recorded and transcribed. Unfilled pauses (silence for a minimum length of 250 ms), filled pauses, repeats, and false starts were analyzed. *Results:* The results of the first story indicated that the third sentence of "abnormal" stories contained an increased number and duration of pauses compared to the typical or "normal" stories. The duration of pauses after the third sentence was also greater in the "abnormal" stories compared to the "normal" stories. In addition, the participants required more time between reading the first story and retelling the first story in the "abnormal" condition. The results of the second story revealed that the third sentence in the "abnormal" stories contained an increased number and duration of pauses compared to the "normal" stories. The reading and retelling of the first story influenced the pause duration in the reading of the second story. If a participant first read and retold a "normal" story, there was an increased pause duration after the third sentence in the subsequent "abnormal" story (and vice versa). However, if a participant first read and retold an "abnormal" story, he/she exhibited short pauses after the third sentence in the subsequent "abnormal" story (and vice versa). 73% of filled pauses occurred after an unfilled pause, and an unfilled pause occurred after 47% of the filled pauses in the retelling of the first and second stories. 61% of unfilled pauses in the first and second readings occurred between sentences. More pauses were included overall in the "abnormal" conditions. More pauses were included in the second retelling when the first reading and retelling were "abnormal" compared to "normal." The greatest number of pauses were included in the "normal" story when it followed an "abnormal"

story. The least number of pauses were included in the “normal” story when it followed a “normal” story. In the first retelling, 60% of pauses fell within major syntactic units, and in the second retelling, 57% of pauses fell within major syntactic units. Unfilled pauses were included more often before function words than content words. *Conclusions:* The semantic context of the first reading and retelling influenced the results of the second reading. Most filled pauses occur after unfilled pauses in an attempt to maintain a conversational turn. Pauses give the speaker additional time to cognitively process speech or information that was just said/given or to process what is about to be said/given. Additional semantic processing time is required for utterances that are least expected due to the semantic content that occurred before. *Relevance to Current Study:* This study explores how semantics influence pauses in speech.

Roberts, F., & Francis, A. L. (2013). Identifying a temporal threshold of tolerance for silent gaps after requests. *Acoustical Society of America, 133*(6), 471-477. doi:10.1121/1.4802900 *Objective:* To determine how long a silent pause needs to be before the listener becomes concerned about the successfulness of his or her social interaction. *Methods:* In this study, 386 college students, ages 18-32, listened to 15 brief telephone conversations where the caller extended an invitation or request, and the recipient gave an affirmative response. Silent pauses that ranged from 200 to 1200ms in 100ms intervals were placed between each of the requests/invitations and affirmative responses. Each of the college students were asked to rate their perception of the call recipient’s eagerness for the request/invitation. *Results:* As the duration of a silent pause increases, the listener’s perception of eagerness/willingness decreases. Pauses between 100ms and 600 ms long (at 100 ms increments) were not significantly rated any different in the perception of an

individual's eagerness/willingness. The listener's ratings drop very quickly with pauses from 600-700ms, and a statistically significant decline in ratings from 700-800ms. *Conclusions:* A non-linear relationship exists between silent pause length and a listener's perception of unwillingness. The perception of a person's eagerness/willingness is greater before 500 ms, declines after 600 ms, significantly decreases from 700-800 ms, and experiences a basement effect after 900 ms. *Relevance to Current Study:* Silent pauses greater than 600 ms before a response is given are associated with negative judgements by listeners.

Scherer, K. R., London, H., & Wolf, J. J. (1973). The voice of confidence: Paralinguistic cues and audience evaluation. *Journal of Research in Personality, 7*(1), 31-44. doi: 10.1016/0092-6566(73)90030-5

Objective: This study investigated the paralinguistic features of speech in an individual with a confident voice. This study also examined how listeners perceive a "confident" text and a "confident" voice. *Methods:* A speaker was recorded reading a "linguistically confident" and a "linguistically doubtful" text in a "confident" voice and in a "doubtful" voice. All 4 recordings were played for 10 listeners, and the listeners were asked to report which tape sounded more confident. Each recording was analyzed for pauses and other acoustic parameters of speech. 47 women were randomly selected to listen to 1 of the 4 recordings. They were then required to complete a questionnaire in regard to the speaker's confidence, expertise, competence, and a variety of other personality and speech traits. *Results:* The results of the most confident condition to the least confident condition are the following: Confident text in confident voice, doubtful text in confident voice, confident text in doubtful voice, doubtful text in doubtful voice. A "confident"

voice contained greater energy, higher pitch, and a faster rate of speech than a "doubtful" voice. The speaker used a higher pitch to portray confidence while reading the "linguistically doubtful" text but not when reading the "linguistically confident" text. The speaker included less pauses in his speech when reading in a "confident" voice. When the speaker did pause in this condition, his pauses were shorter than when he read in a "doubtful" voice. The "confident" text was perceived as more conceited, professional, and businesslike than the "doubtful" text. The "confident" speaker was perceived as an individual who was more enthusiastic, forceful, active, and competent compared to the "doubtful" speaker. The "confident" speaker was also perceived to be speaking at a louder volume, to be speaking faster and more expressively, and to be speaking more fluently. *Conclusions:* Speakers can compensate for "linguistically doubtful" features by altering the paralinguistic features in their voices. Confident linguistic material may be used best for accomplishing tasks or communicating in a professional manner. "Confident" voices are perceived as more competent than "doubtful" voices. The acoustic features of speech loudness, pitch, and rate, as well as the number and duration of pauses, all contribute to a "confident" voice. *Relevance to Current Study:* This study examines which features of speech contribute to a "confident" voice. This study also explores a listener's perception of "confident" speech.

Taylor, I. (1969). Content and structure in sentence production. *Journal of Verbal Learning and Verbal Behavior, 8*(2), 170-175.

Objective: This study analyzed whether speech pauses were more affected by a sentence's content or structural complexity. *Methods:* Twenty students participated in this study. Each participant was provided with a word (written on a card and spoken

aloud by the examiner) and was asked to produce one complete sentence with that word as soon as it was given to them. Each participant was provided with an example word and example sentences at the beginning of the study. The words used in this experiment belonged to one of four categories (Infrequent Abstract, Frequent Abstract, Infrequent Concrete, and Frequent Concrete), and each category contained an equal number of nouns, verbs, and adjectives. Each participant was asked to produce sentences for 120 words. The researchers measured and analyzed each participant's speech onset latency, sentence length, structural complexity, and type, and hesitations. *Results:* More hesitations occurred in the speech containing "infrequent" topics. An increased number and duration of pauses occurred in the speech containing Frequent Abstract words compared to Frequent Concrete words. "Infrequent" topics required more encoding operations than "frequent" topics. Most of the participants created simple-active-affirmative-declarative (SAAD) sentences with a topic word of any category. When the participants created other types of sentences, they created more passive sentences for "infrequent" words than "frequent words". They also created more negative sentences for "frequent" words than "infrequent words". Overall, the speech onset latency times ranged from .5 to 48 seconds across participants. The largest mean speech onset latency occurred for Infrequent Abstract words, and Infrequent Concrete Words, Frequent Abstract words, Frequent Concrete words followed close behind it. "Infrequent" words contained longer speech onset latencies than "frequent" words. Subjects did not have longer speech onset latencies for longer sentences. The speech onset latency for Non-SADD sentences did not significantly differ from the overall mean latency of sentence types. *Results:* A sentence's content complexity mainly affects the development of a sentence. In particular, content complexity affects both the initial sentence production (as shown by speech onset latency) and the production of the entire sentences (as shown by hesitations/pauses). Sentence length does not demonstrate the amount of sentence development or conceptualization. *Relevance to Current Study:* The conceptualization of sentences relies more on a sentence's content complexity rather than structural complexity. Thus, pauses in a person's speech are largely influenced by the complexity or difficulty of semantic content.

APPENDIX B

Informed Consent

Consent to be a Research Subject

Title of the Research Study: Communication Impact of Speech Pause
Principal Investigator: Shawn Nissen, Ph.D.
IRB ID#: IRB2020-479

Introduction

This research study is being conducted by Shawn Nissen, Ph.D., at Brigham Young University to determine how the characteristics of an individual's speech impacts their ability to communicate effectively. You were invited to participate because you are a native English speaker with typical hearing.

Procedures

If you agree to participate in this research study, the following will occur:

- you will participate in a hearing screening by listening to beeps through headphones while seated in a listening booth in the Taylor building on the Brigham Young University campus
- you will listen to a series of sentences and short conversations and rate each sample on how well it was spoken using a computer mouse to select a button on the screen
- the entire study will take 55 minutes to complete

Risks/Discomforts

There are minimal risks for participation in this study. You may encounter some discomfort from wearing the over-the-ear headphones. You will take a short break in the middle of the study to limit possible discomfort from wearing the headphones. There is also a small risk that your participation in the study may be known to others by your signing the consent form. The consent forms will be kept in a locked cabinet within a locked room to decrease this risk.

In Case of Research Related Injury

BYU makes no commitment to provide financial compensation or free medical care should you be injured as a result of your participation in this research. Nonetheless, in the event of such an injury, after seeking appropriate medical attention, please contact Shawn Nissen at (801) 422-5056 or shawn_nissen@byu.edu.

Benefits

There are no direct benefits to you. It is hoped this study will provide understanding in how to help individuals learn to communicate more effectively.

Confidentiality

All data, including records of your listening responses, will be kept on password-protected computers in a locked laboratory and only those directly involved with the research will have access to them. The consent forms with the participant signatures is what will be stored in a locked cabinet.

De-identified data from this study may be shared with the research community, with journals in which study results are published, and with databases and data repositories used for research. We will remove or code any personal information that could directly identify you before the study data are shared. Despite these measures, we cannot guarantee anonymity of your personal data.

Compensation

You will receive $10 in cash for your participation in this study.

Participation

Participation in this research study is voluntary. You have the right to withdraw at any time or refuse to participate without penalty.

Questions about the Research

If you have questions regarding this study, you can contact the principal investigator Shawn Nissen at (801) 422-5056 or shawn_nissen@byu.edu.

Questions about Your Rights as Research Participants

If you have questions regarding your rights as a research participant contact Human Research Protections Manager by phone at (801) 422-1461; or by email: irb@byu.edu.

Statement of Consent

I have read, understood, and received a copy of the above consent and desire of my own free will to participate in this study.

Name (Printed):________________________**Signature:**________________________**Date:** ________