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Does the Severity of Dysarthria Experienced by Training Talker Affect the Perceptual Learning Effectiveness in Listeners

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ABSTRACT

The purpose of this study was to investigate if perceptual learning is generalizable to different severities of dysarthria secondary to amyotrophic lateral sclerosis (ALS). Five individuals with dysarthria secondary to ALS participated as speakers (two mild dysarthric speakers, two severe dysarthric speakers, and one control speaker who was classified with mild dysarthria). Thirty listeners engaged in a pretest, familiarization (training), and posttest design. The pretest and posttest were identical in structure and stimuli; however, during the familiarization portion listeners were randomly assigned to one of two training conditions, mild or severe. During the training portion listeners additionally received feedback on their responses. Results concluded that perceptual adaptation differed depending on the training condition. Perceptual adaptation was not demonstrated when listeners received the severe training condition as there was a decrease in intelligibility from pretest to posttest. However, there was generalization in the listeners who received the mild training condition as there was an increase in intelligibility from pretest to posttest.

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Chapter 1

Introduction

Communication is an essential function that all utilize throughout life. Communication allows one to express their thoughts, opinions, needs, and wants. For most people communication occurs effortlessly; however, when one acquires a disease or disorder this can disrupt the ability to communicate with others. Among these diseases are those such as Amyotrophic Lateral Sclerosis (ALS) and Parkinson's Disease (PD). A similar deficit that characterizes these two diseases is a speech sound disorder referred to as dysarthria. Dysarthria is when one has difficulty speaking because the muscles used for speech are weak. General features of dysarthria include reduced vowel space, speaking rate, formant transitions, and phonetic contrast. Vowel space refers to various changes in the acoustic quality of vowels due to the weakness of muscles used for speech resulting in changes in stress, duration, loudness, and articulation of the vowel. Speakers with dysarthria also exhibit a reduced speaking rate due to slow and irregular pauses. Additionally, dysarthric speech is characterized by reduced formant transitions. Formant transitions are rapid changes within the vocal tract carried out by our articulators and if our articulators are weak formant transition speed decreases. Reduced phonetic contrasts are small differences in speech that allow each phoneme (smallest unit of speech, for example an individual sound such as /b/) to be perceived differently by the listener. Articulation is affected by these small differences and results in phonemes being highly confusable. (Borrie, Lansford, and Barrett, 2017).

Dysarthria can be degenerative resulting in a decrease in intelligibility of one's speech overtime when accompanied by progressive diseases such as ALS and PD. To assist in speech rehabilitation it is most common to have therapy focused on the speaker. This type of therapy accomplishes very little as the speech of one with dysarthria secondary to degenerative diseases will continue to deteriorate. A therapy approach that would be more beneficial is the ability to train listeners to better decipher dysarthric speech. Due to the degeneration of dysarthria secondary to progressive diseases research can investigate if training a listener in one severity of dysarthria is generalizable to other severity levels in order to assist intelligibility throughout the progression of the disease.

Perceptual Learning

Speech perception requires listeners to accurately determine the continuous incoming signal into word-size frames and map them onto discrete meanings (Borrie & Lansford, 2021). This process occurs with no effort in a familiar situation. However, if a listener encountered a speaker who has a novel way of talking, such as a person who stutters or an English language learner (ELL), the speech perception system must rapidly adapt to these unfamiliar cues in order to map them onto linguistic categories stored in memory. The knowledge of the acoustic regularity in the speech signal is fundamental in order to acquire this knowledge. The acoustic regularity arises from the segmental and suprasegmental information in speech. A speaker that has extensive experience with novel speech stimuli allows the listeners to extract regularities in the atypical acoustic patterns (Borrie et al., 2012). However, the acoustic degeneration that characterizes speech of those with dysarthria is irregular and unpredictable resulting in difficulty of perceptual adaptation.

Acoustic Patterns and Vowel Intelligibility of Dysarthric Speech

Dysarthria secondary to progressive diseases results in a severely degraded acoustic signal reducing intelligibility. Lee, Dickey & Simmons (2019) explored the vowel-specific intelligibility and acoustic patterns of individuals with different severities of dysarthria to determine the key acoustic contributors of intelligibility as certain vowels are more or less vulnerable than others. Speakers with mild and severe dysarthria produced ten monophthongs in a control consonant context with electromagnetic sensors attached to their articulators. The electromagnetic sensors demonstrated that speakers did not maintain vowel-specific contrast among acoustic variables which resulted in some vowels being far from its prototype. This concluded that the vowel-specific intelligibility pattern is related to both vowel-specific characteristics and group-specific articulatory control dysfunction. Listeners completed two tasks which were the speech intelligibility test (SIT) and the forced-choice vowel intelligibility test. Data from these tests were extracted and a confusion matrix was made which concluded that vowel specific intelligibility patterns differ across severity groups specifically in comparison to those classified with severe dysarthria. These findings can guide clinical approaches to target intervention on the less intelligible vowels or if improvement in intelligibility is ineffective to develop compensatory strategies.

Techniques to Increases Intelligibility of Dysarthric Speech

Familiarization and Feedback

Due to the decreased intelligibility of dysarthric speech Borrie, McAuliffe, Liss, Kirk, and O'Beirne (2012) explored how to increase intelligibility through familiarization and type of feedback. Three groups of listeners were familiarized with a passage reading under one experimental condition. These conditions consisted of neurologically intact speech, dysarthric speech, and dysarthric speech paired with feedback which was a written transcription. Several major conclusions were drawn from this research. The first finding demonstrated that intelligibility improved significantly following a brief familiarization experience with dysarthric stimuli. Secondly, the robustness of intelligibility benefits was influenced by the type of familiarization experience. Listeners demonstrated significant gains when dysarthric speech was paired with a written transcript. This study yielded empirical support for the possible benefits of perceptual learning of dysarthric speech by revealing information on the relationship between familiarization and type of feedback.

Similarity of Perceptual Features

It has been determined by Borrie, McAuliffe, Liss, Kirk, and O'Beirne (2012), as well as others, that perceptual learning of dysarthric speech is improved through familiarization specifically when given feedback. However, an open question is whether there are specific features within dysarthric speech that can assist in perceptual adaptation. These features were explored by Borrie, Lansford & Barret (2017). Specifically, they were curious if the similarity of perceptual features during a familiarization task predicts adaptation to a talker with dysarthria and if severity level of dysarthria predicts adaptation. The term perceptual features refers to the rate, pitch, loudness, and etc. of speech. Each participant engaged in the same pretest and posttest and following the pretest there was a familiarization task using lexical feedback. Participants each heard the same short passage with written subtitles; however, similarity of perceptual features differed based on condition assigned. Transcripts from the pretest and posttest were both analyzed to test adaptation of the listener. Results concluded that perceptual adaptation to a talker with dysarthria can be predicted by the nature of the familiarization experience, similarity of perceptual features, and level of intelligibility. Listeners who were familiarized with dysarthric speech demonstrated increased adaptations than those who were not. However, listeners familiarized with a talker exhibiting similar perceptual features were superior in perceptual adaptation compared to listeners familiarized with a talker with dissimilar perceptual features. Level of intelligibility provides a constraint in perceptual adaptation as it was observed that perceptual adaptation was significantly reduced for listeners presented with a low intelligibility. These results suggest that there could be a possible threshold of perceptual adaptation. For example, listeners who are sensitive to the structure of speech specifically demonstrated more difficulty with low intelligibility. Therefore, clinical intervention programs should focus training in mild to moderate dysarthria.

Listener Intelligibility versus Comprehension

Hustad (2008) examined the relationship between listener comprehension and intelligibility scores across severity. Intelligibility refers to how well a speaker's acoustic signal can be accurately recovered by the listener. Listener comprehension evaluates a listener's ability to interpret the meaning of a message. To determine this relationship speakers with dysarthria were assigned to each of the four severity groups (mild, moderate, severe, and profound). Each speaker produced a narrative and from this narrative listeners were asked to make orthographic transcriptions of each sentence as well as complete ten comprehension questions at the end. Results concluded across all speakers and their listeners that there was no significant relationship between intelligibility and comprehension scores when severity effects were removed meaning that there is no overlap between intelligibility and comprehension. Overall, comprehension scores tended to be higher than intelligibility scores which demonstrated that even if a speaker has an impaired acoustic signal it may be enough for an adequate message exchange to the listener.

The Optimal Perceptual Training Protocol

These studies (as well as others) laid the groundwork in perceptual learning, but in order to develop an optimal perceptual learning training protocol Borrie and Lansford (2021) conducted a comprehensive review of this literature. The specific variables analyzed across these studies were the learning source, task parameters (explicit familiarization and vocal imitation), listener parameters (rhythm perception, age and hearing status, and listener experience), and speaker parameters (signal predictability). The analysis concluded that there are three essential aspects of familiarization which are feedback, materials, and dosage. In terms of feedback there is indication for using both lexical and somatosensory feedback during familiarization. Lexical feedback during familiarization promotes mapping of the ambiguous acoustic realizations onto meaningful internal representations of speech. Somatosensory feedback refers to imitation which promotes familiarization indirectly by linking the acoustic target with the somatosensory information required to produce that sound (Borrie and Schafer, 2015). Materials refer to the stimuli utilized during the familiarization training which range from words list, single sentences, and passage/paragraph productions. Borrie, McAuliffe, Liss, Kirk, et al. (2012) concluded that utilizing linguistically rich passages as stimuli provided substantial benefits in perceptual learning. An important outcome of any clinical intervention is maintenance over time. Therefore, when designing an optimal perceptual training paradigm one needs to consider the immediate improvements as well as the longevity of these improvements. Borrie and Schäfer (2017) reported maintenance of intelligibility up to one month following familiarization with a brief familiarization dosage. It is possible that only a relatively short familiarization experience is required to increase intelligibility benefits; however, it is imperative to explore if an increase in intelligibility can be further optimized through a more extensive perceptual learning protocol.

Perceptual Learning of Dysarthric Speech

Prior research established that perceptual learning of dysarthric speech is possible through familiarization with several necessary components. First, intelligibility is improved when listeners are provided with dysarthric speech; however, intelligibility is significantly improved when listeners were familiarized with dysarthric speech that had similar perceptual features. Vowels do not maintain their vowel-specific characteristics among acoustic variables such as tongue height. It was observed that reduced intelligibility of high and mid vowels was due to the reduced control in tongue movement which resulted in a vowel becoming highly confusable. The consideration of the vowel-specific intelligibility patterns ensures that stimuli consists of speakers with similar perceptual features. Secondly, feedback during familiarization is essential, but the type has been debated. There is growing support for both lexical and somatosensory feedback. Despite the increasing evidence of the benefits of perceptual learning a major drawback is the level of intelligibility of the speaker as low intelligibility resulted in a decreased perceptual adaptation. With this being said, comprehension scores tended to be higher than intelligibility scores. The improvement in listener comprehension is not sufficient enough to support communication and is not reliable.

Purpose of the Study

The purpose of the current study was to investigate whether a listeners' perceptual learning benefits obtained from one severity of dysarthria can be generalized to different severity levels of dysarthria secondary to progressive diseases. Specifically, the following two key research questions were addressed: (a) Does perceptual learning differ depending on the severity of training talker? (b) Does learning generalize from one severity to another severity (more or less severe)? It was hypothesized that perceptual learning would differ depending on the severity of the training talker. For example, perceptual adaptation following familiarization of mild dysarthria would be superior to perceptual adaptation achieved during familiarization of severe dysarthria. However, a higher intelligibility overall would be documented when a listener is trained in severe dysarthria as it would be generalized to mild dysarthria as well. Whereas training a listener in mild dysarthria may not generalize or be more difficult to generalize to an increased severity level.

Chapter 2

Methods

Listener Participants

Thirty adults (nineteen men, ten females, and one nonbinary person) aged 23-69 years old (Mean (*M)* = 39.1) participated in this experiment. All participants were native speakers of American English and resided in the United States. Participants reported no history of speech, language, or hearing problems and had no significant prior contact with persons having speech and/or language disorder.

Participants were recruited using the crowdsourcing website Prolific (Prolific: https://www.prolific.com/). All participants were paid workers and were protected through Prolific participation agreement and privacy notice. Prolific's setup option regarding participant screening requirements was utilized permitting only monolingual English speakers. It was also requested that all participants had no prior history of language disorders.

Speech Stimuli

Test Talkers

Speech stimuli used in this investigation were selected from an extensive pool of audio recordings of talkers with dysarthria secondary to ALS, collected as part of a larger project conducted by Dr. Jin Min Lee. The test stimuli consisted of a set of nine /h/-vowel-/d/ words that were collected from three speakers; two mild speakers (one being the control condition who demonstrated the most intelligibility) and one severe speaker. The set of the nine /h/-vowel-/d/ words were repeated a total of three times by each speaker producing twenty-seven productions for a total of eighty-one productions across the three speakers.

Familiarization Talkers

The familiarization stimuli was composed of the same set of nine /h/-vowel-/d/ words. The familiarization talkers were different speakers from the test talkers. There was one mild speaker and one severe speaker creating two familiarization conditions. These speakers were chosen due to their vowel-specific intelligibility patterns. Each vowel has unique acoustic characteristics; therefore, acoustic correlates of vowel intelligibility differ by vowel with some that are more critically impaired than others in individuals with dysarthria secondary to ALS (Lee, Dickey, and Simmons, 2019). Impairment in vowel acoustics affects speech intelligibility as vowels can become highly confusable among each other. Specifically, in the current study the familiarization talkers were matched to the mild and severe pretest and posttest talkers by similarity of their vowel confusion pattern.

Table 1 and Table 2 demonstrate the vowel confusion patterns among the mild speakers chosen for the pretest, posttest, and training. The cells represent the percentage of response frequency. Across these matrices there is similarity in the vowel confusion pattern between speakers. For example, in both table 1 and 2 when the vowel /u/ in the word “who’d” is a produced by a speaker with dysarthria this vowel is similarly confused with the vowel /ʊ/ (in the word “hood”) and the vowel /oʊ/ (in the word “hoed”). Patterns similar to this are exhibited across each vowel in both of the mild speakers.

Table 1.

Vowel Confusion Matrix for Mild Pretest and Posttest Speaker

		Perceived Vowel (%)									
		hood	hawed/hod	hoed	hud	heed	hid	head	who'd	had	
Produced Vowel	hood	78	11	0	11	0	0	0	0	0	100
	hawed/hod	0	94	0	6	0	0	0	0	0	100
	hoed	0	0	100	0	0	0	0	0	0	100
	hud	11	0	0	56	0	11	11	0	11	100
	heed	0	0	0	0	78	22	0	0	0	100
	hid	0	0	0	0	0	44	56	0	0	100
	head	0	0	0	0	0	0	78	0	22	100
	who'd	33	0	56	0	0	0	0	11	0	100
	had	0	0	0	0	0	0	0	0	100	100

Note. The vowel confusability pattern observed in the mild speaker in the pretest and posttest.

Table 2.

Vowel Confusion Matrix for Mild Training Speaker

		Perceived Vowel (%)									
		hood	hawed/hod	hoed	hud	heed	hid	head	who'd	had	
Produced Vowel	hood	78	0	11	11	0	0	0	0	0	100
	hawed/hod	0	83	6	6	0	6	0	0	0	100
	hoed	22	0	56	0	0	0	0	0	0	100
	hud	0	0	0	89	0	11	0	0	0	100
	heed	0	0	0	0	100	0	0	0	0	100
	hid	0	0	0	0	0	78	22	0	0	100
	head	0	0	0	0	0	0	100	0	0	100
	who'd	22	0	33	0	0	0	0	44	0	100
	had	0	0	0	0	0	0	22	0	78	100

Note. The vowel confusability pattern observed in the mild speaker in the pretest and posttest.

Table 3 and 4 additionally demonstrate the vowel confusion patterns among the severe speakers. In comparison to the mild speakers' the listeners appeared to experience more difficulty in accurately identifying the correct word for the severe dysarthric speakers as there is a larger range in the vowel confusability pattern. For example, in both table 3 and 4 the vowel /æ/ (represented by the word "had") is confused with the vowel /ɪ/ (in the word "hid"), and the vowel /ε/ (in the word "head"). Patterns such as this are exhibited across each vowel in both of the severe speakers.

Table 3.

Vowel Confusion Matrix for Severe Pretest and Posttest Speaker

		Perceived Vowel (%)									
		hood	hawed/hod	hoed	hud	heed	hid	head	who'd	had	
Produced Vowel	hood	44	0	11	33	0	0	0	0	11	100
	hawed/hod	6	56	11	17	0	11	0	0	0	100
	hoed	22	11	44	11	0	0	0	11	0	100
	hud	0	44	11	11	0	11	0	0	22	100
	heed	0	0	0	0	11	33	22	0	33	100
	hid	0	0	11	0	0	11	67	0	11	100
	head	0	0	11	0	0	0	22	0	67	100
	who'd	22	11	11	33	0	0	0	44	0	100
	had	0	33	0	0	0	11	22	0	33	100

Note. The vowel confusability pattern observed in the mild speaker in the pretest and posttest.

Table 4.

Vowel Confusion Matrix for Severe Training Speaker

		Perceived Vowel (%)									
		hood	hawed/hod	hoed	hud	heed	hid	head	who'd	had	
Produced Vowel	hood	11	11	67	11	0	0	0	0	0	100
	hawed/hod	0	22	6	0	0	67	0	0	6	100
	hoed	22	0	44	33	0	0	0	0	0	100
	hud	0	44	11	0	0	33	11	0	0	100
	heed	0	0	11	0	56	11	22	0	0	100
	hid	0	33	11	0	0	11	44	0	0	100
	head	0	11	0	0	0	0	67	0	22	100
	who'd	56	11	11	0	11	0	0	11	0	100
	had	0	0	0	0	0	33	22	0	44	100

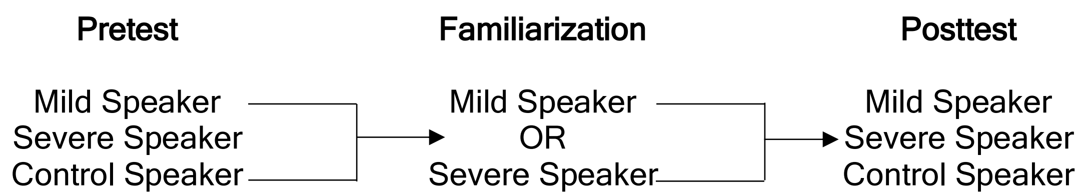
Note. The vowel confusability pattern observed in the mild speaker in the pretest and posttest.

Procedure

A brief description of the study task, requirements (use of headphones), time commitment (approximately 30 minutes) and remuneration amount ($6) were posted on Prolific. Before starting the study, participants read through general instruction of what the study entailed as well as a statement of voluntary participation allowing them to withdraw at any time. Participants were then required to complete a hearing screening and upon successful completion participants began the study. The design of the study consisted of a pretest, familiarization (training), and posttest. Figure 1 represents the chronological order of the tasks that the listener engaged in while completing the study.

Figure 1.

Pretest-Familiarization (Training)-Posttest



Note. The order of stimuli presented to the listener who were randomly assigned during familiarization to receive either mild or severe dysarthric speech.

All participants engaged in the same pretest. Participants were informed they would be hearing words produced by a person with a speech disorder and their job was to identify the word and to click the option that best matched what they heard. Words were presented one at a time, and following each presentation, participants were instructed to select what they thought was being said from a set of nine multiple choice options with each target response accompanied by a word that rhymed with it. Participants were encouraged to guess if unsure. Once participants had selected their answer they were prompted to press the space key to move onto the next phase. Participants heard a total of eighty-one stimuli, twenty-seven from each of the three speakers. The presentation order of the pretest words was randomized across participants.

Following the pretest, participants received one of two training conditions (mild or severe). Participants were instructed that they would hear words produced by a person with a speech disorder and that their job was to select the word that best matched with what they heard. Selection of the target word was similar in presentation as the pretest; however, after selection the participants would receive feedback. Feedback consisted of "Correct" or "Incorrect" and they also received the correct target response. Participants were then prompted to press the space key to move onto the next phase. Participants heard a total of twenty-seven stimuli in the training task. The presentation order of the stimuli across conditions and participants was randomized. At the end of the familiarization all participants engaged in the same posttest, which was identical in structure and stimuli to the pretest.

Data Analysis

The total data set consisted of 80 test trials: 40 test trials of the pretest and 40 test trials of the posttest which were analyzed for a standard measure of speech intelligibility, that is, percent words correct (PWC). Two PWC scores were calculated for each participant, one for the pretest and one for the posttest. These scores reflected a measure of intelligibility for each participant before and after the familiarization experiences. Participants PWC scores were averaged to reflect the overall change in intelligibility from pretest to posttest.

Chapter 3

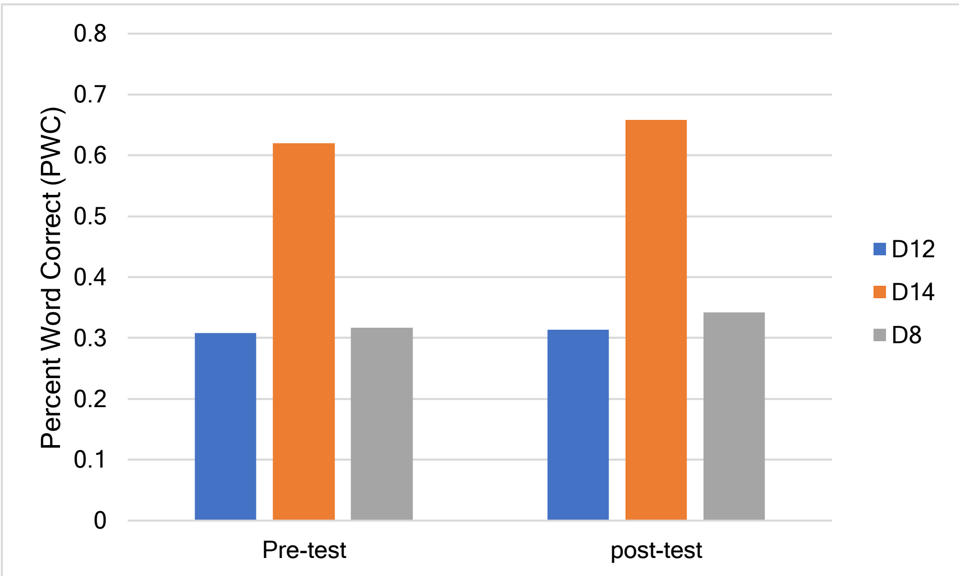
Results

Overall Intelligibility

The PWC scores demonstrated the change (increase or decrease) in intelligibility from pretest to posttest. Table 5 shows the averaged PWC scores across all conditions (mild and severe) and all speakers. Speaker D12 was classified as severe, speaker D14 was mild, and speaker D8 was the control speaker.

Table 5.

Accuracies of Pretest and Posttest across all Conditions and Speakers



Note. The graph displays the average pretest and posttest intelligibility in the mild and severe condition separated by speaker.

The PWC scores across each condition and speaker revealed an increase in intelligibility from the pretest (M = 0.42, SD = 0.17) to posttest (M = 0.44, SD = 0.19) following familiarization. These results reflect similar findings of previous studies in that there is an increase in intelligibility following a familiarization experience; therefore, demonstrating a listener's perceptual adaptation to dysarthric speech.

Intelligibility Based on Condition

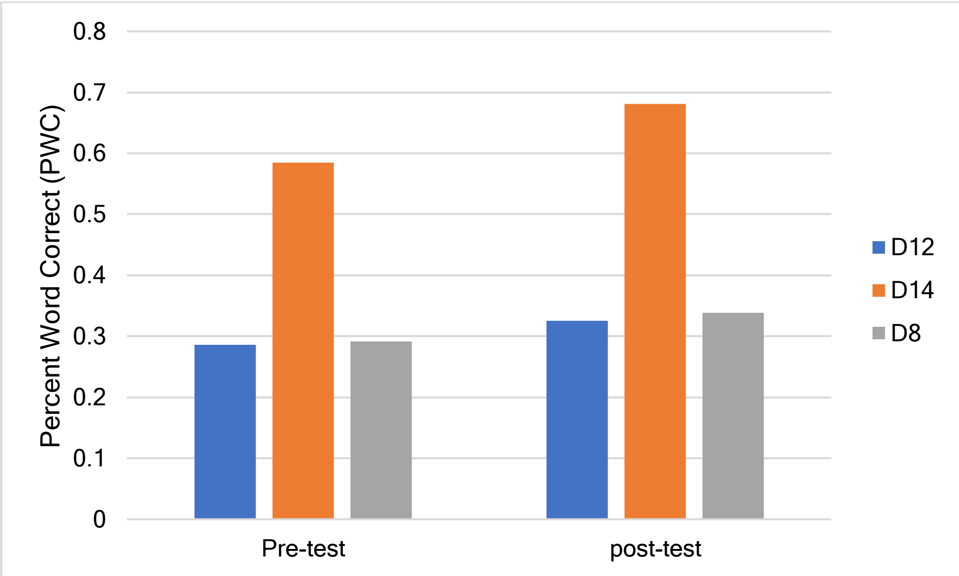
When the condition of the familiarization experience was factored in there was a difference in intelligibility improvements from pretest to posttest.

Mild Condition

Table 6 shows the PWC scores of listeners who were assigned the mild condition. The PWC scores of listeners familiarized with mild dysarthric speech demonstrated an increase in intelligibility from pretest (M = 0.39, SD = 0.17) to posttest (M = 0.45, SD = 0.20) across all speakers. These results suggest that training in mild dysarthria not only yields to an increase in intelligibility of mild dysarthric speech, but also severe dysarthric speech.

Table 6.

Pretest and Posttest Accuracies Across all Speakers in the Mild Condition

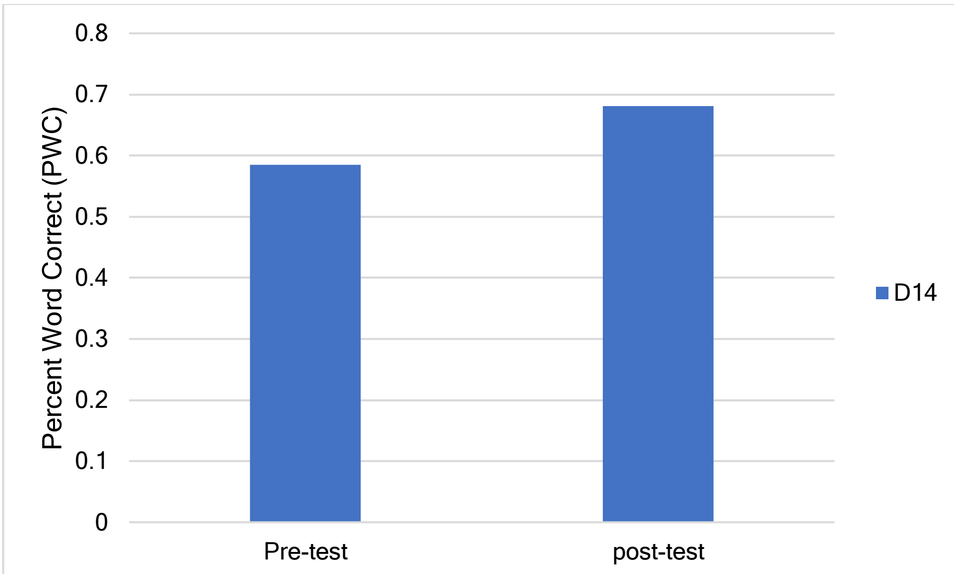


Note. The graph displays the pretest and posttest intelligibility in the mild condition separated by speaker.

Familiarization consisted of a different speaker than the speaker utilized during the pretest and posttest. Table 7 displays an increase in pretest to posttest accuracies in the mild speaker suggesting that training was generalizable across different speakers as well.

Table 7.

Pretest and Posttest Accuracies of the Mild Speaker in the Mild Condition



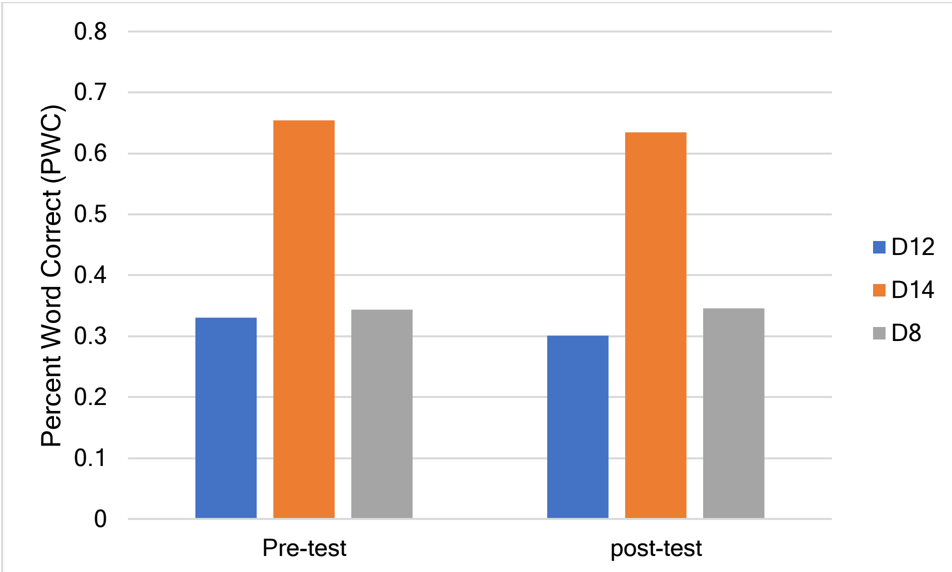
Note. The graph displays the pretest and posttest intelligibility of the mild speaker when the listener completed familiarization in the mild condition.

Severe Condition

Table 8 presents the PWC scores of listeners who were assigned the severe condition. The PWC scores of listeners familiarized with severe dysarthric speech resulted in a decrease in intelligibility from the pretest (M = 0.44, SD = 0.18) to posttest (M = 0.43, SD = 0.18). However, the decrease from pretest to posttest was only observed in the mild and severe dysarthric speakers whereas the control speaker (D8) demonstrated an increase in intelligibility from pretest to posttest, this can be seen in table 9. These results suggest that training in severe dysarthric speech was not only not generalizable across severity, but it was also ineffective within severity.

Table 8.

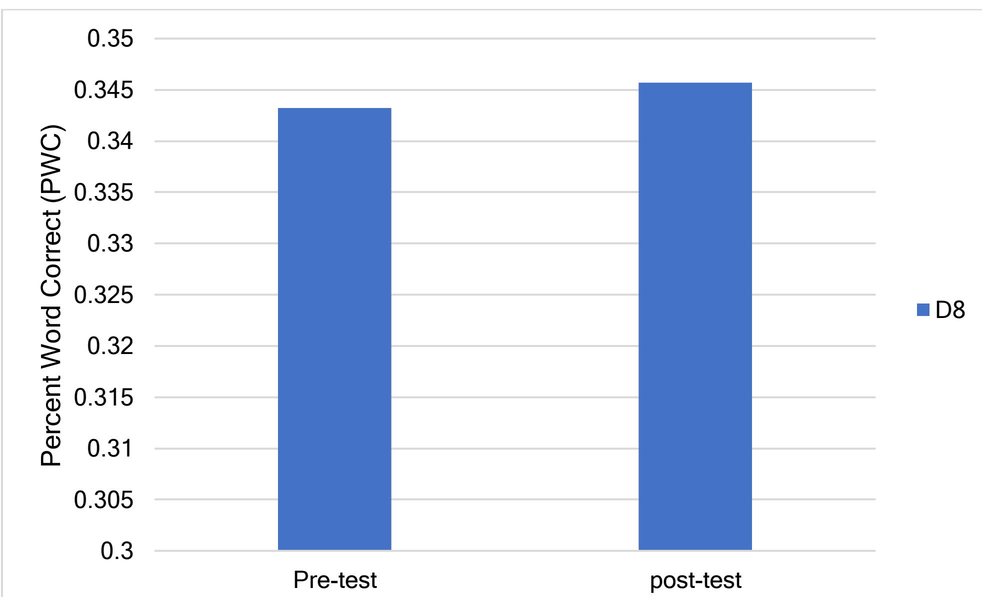
Pretest and Posttest Accuracies Across all Speakers in the Severe Condition



Note. The graph displays the pretest and posttest intelligibility in the severe condition separated by speakers.

Table 9.

Pretest and Posttest Accuracies in the Severe Training with the Control Talker



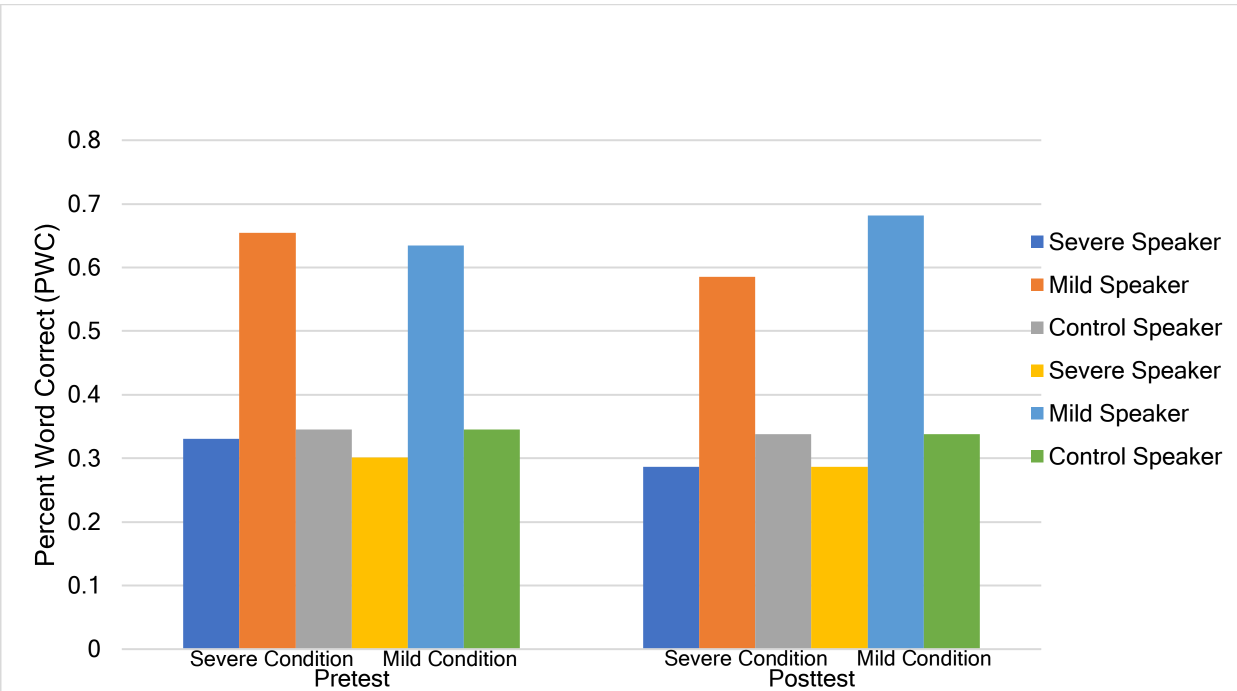
Note. The graph displays the pretest and posttest intelligibility of the control speaker when the listener completed familiarization in the severe condition.

Mild Condition versus Severe Condition

Table 10 provides a comparison between the pretest and posttest accuracies across the severe and mild conditions. Results of the pretest revealed both the severe and mild condition have similar results in intelligibility; however, following familiarization there are different trends in intelligibility. The PWC scores in the mild condition increase from pretest to posttest; whereas, in the severe condition PWC scores decrease from pretest to posttest.

Table 10.

Comparison of Pretest and Posttest Accuracies Across Condition



Note. The graph displays the pretest and posttest intelligibility of each speaker separated by condition (mild and severe).

Chapter 4

Discussion

This study focused on the perceptual learning of dysarthric speech, specifically if training was generalizable across severity. Consistent with previous literature, this study confirmed the ability of listeners to adapt to novel speech produced by individuals with dysarthria. Additionally, perceptual learning is generalized across severities as participants improved in intelligibility following training. Furthermore, this data provided evidence of generalization of perceptual learning across different speakers.

This study examined generalization of training in two conditions: mild dysarthric speech and severe dysarthric speech. The data suggests in mild dysarthric speech that intelligibility improvements can be achieved across severity as well as speakers. However, intelligibility improvements were not seen when listeners were trained in severe dysarthric speech as intelligibility decreased across severity after training.

Mild Condition

An improvement in posttest accuracies were observed after listeners were trained in mild dysarthric speech. An increase in intelligibility was observed across severities indicating that training in mild dysarthric speech is generalizable. Additionally, the speakers utilized during the pretest and posttest consisted of different speakers that were used during the training phase indicating that perceptual learning is generalizable across speakers. Overall, when dysarthria is secondary to progressive diseases (such as ALS) listener-centered intervention should focus on training in mild dysarthric speech.

Severe Condition

The current study suggests that generalization of the perceptual learning of dysarthric speech across severity is not observed when listeners are trained in severe dysarthric speech. Posttest accuracies decreased following training in severe dysarthric speech in both the mild and severe dysarthric pretest and posttest speakers. However, an improvement in intelligibility was documented in the control speaker. This difference may be due to the more intelligible speech in the control speaker resulting in easier comprehension for the listener. Additionally, in severe dysarthric speech the acoustic signal is severely degraded resulting in comprehension being quite difficult. As a result, the effect of fatigue could have played a role in the decrease in intelligibility from pretest to posttest. These suspicions are speculative and require further research. Overall, when dysarthria is secondary to progressive diseases (such as ALS) training in severe dysarthric speech should not be utilized.

Conclusion and Clinical Implications

Many researchers have observed that listeners can adapt to dysarthric speech through exposure and practice. This adaptation improves listeners comprehension of dysarthric speech implying that listeners are an important component in improving the communication exchange between individuals with dysarthria. Meanwhile, there is not a full understanding of the maintenance of perceptual learning of dysarthric speech. When dysarthria is secondary to progressive diseases the acoustic signal of speech continues to deteriorate. As a result, in order for training to be most practical improvements would need to be generalizable across severity. Studies of this type have not provided data relating to this idea. Further exploration of this topic may allow researchers and clinicians to develop listener training intervention programs that focus on the improvement in the intelligibility of dysarthric speech as well as generalization of these skills across severity in order to assist in the progression of the disease.

In the current research the idea of the generalization of the perceptual learning of dysarthric speech is explored. The data provided insight into which severity condition provides the most optimal intelligibility improvements and generalization. These improvements occurred after a short training phase which provides evidence that listener training programs can be both effective and efficient. In addition, this study revealed evidence that perceptual learning is generalized across different speakers of the same severity.

These findings can inform the development of listener-centered interventions. Intelligibility improvements were generalized across severity by listeners trained in mild dysarthric speech. Speakers classified with severe dysarthric speech have a severely degraded acoustic signal resulting in more effort placed on the speaker. The increased effort of accurate comprehension of severe dysarthric speech may have resulted in fatigue in the listener. Thus, for listener-centered intervention, training in mild dysarthric speech would be a viable option to enhance intelligibility across the progression of the disease.

In summary, the current findings suggest that through exposure of mild dysarthric speech perceptual adaptation is generalized across severity. Training paradigms that focus on improving intelligibility of dysarthric speech secondary to a progressive disease should consist of mild dysarthria. Likewise, these training programs can be designed in that listeners do not need to receive the same mild dysarthric training speaker in order for improvements in intelligibility to occur.

Limitations and Future Directions

This study was intended to understand the best approach to assist in the intelligibility of dysarthria across the progression of the disorder when secondary to progressive diseases; however, there are limitations on the applicability of these findings.

The current research focused on the generalization of the perceptual learning of dysarthric speech across severity. While generalization of the perceptual learning of dysarthric speech is important when dysarthria is secondary to a progressive diseases this relationship has received little attention from others. The nature of this relationship remains unclear and future research should continue to address this question in order for a clear relationship to be determined.

The effect of fatigue on perceptual learning in the severe condition needs to be further examined. Despite the relatively brief perceptual training utilized there was a decrease in intelligibility from pretest to posttest. Intelligibility increases have been demonstrated in other perceptual learning paradigms. Thus, the current perceptual training paradigm needs to be reevaluated to determine the optimal training length and features in order to decrease the effect of fatigue.

Finally, the length of the perceptual training and maintenance of perceptual adaptation skills needs to be further evaluated. As mentioned, this study utilized a relatively brief perceptual training paradigm. The intelligibility benefits and generalization observed (in training of mild dysarthric speech) in this study suggest that there is a great clinical potential of the perceptual learning and generalization of dysarthric speech. However, many other perceptual training paradigms include a longer perceptual training phase and resulted in greater intelligibility increases. Additionally, in order to assist in the intelligibility throughout the progression of dysarthria, perceptual adaptation needs to be maintained over time. In order to determine if perceptual adaptation was maintained participants would need to complete the perceptual learning paradigm after an extended time period from the initial training to determine if skills were maintained over time.

The current findings urge future studies to investigate the nature of the relationship of perceptual learning and generalization of dysarthric speech across severity, the effect of fatigue on the listener, the optimal perceptual training length and its effect, and maintenance of perceptual adaptation.

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ACADEMIC VITA

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EDUCATION

Bachelor of Science: Communications and Science Disorders, Expected in 05/2024
Pennsylvania State University - University Park, PA

- Dean's List 2020-2023
- Schreyer Honors College
- NSSLHA Member 2020-2023
- THON Committee Member 2020-2024
- Phi Sigma Sigma, Member
- Study Abroad: Rome, History and Classics
- Thesis: Does the Severity of Dysarthria Experienced by Training Talkers Affect the Perceptual Learning Effectiveness in Listeners

PROFESSIONAL SUMMARY

Undergraduate Degree in Communication and Science Disorders from Pennsylvania State University; on track to graduate during the Spring of 2024. Aspire to attend a two-year Graduate Level Program seeking a Master's in Speech-Language Pathology to expand my knowledge in language development, assessment techniques, and intervention strategies for those with speech and/or language difficulties.

SKILLS

- Problem Solving
- Adaptability
- Time Management
- Patience
- Leadership
- Communication

PROFESSIONAL EXPERIENCE

Research Assistant, 01/2022 - Current
Collaborative Language Use Lab – Pennsylvania State University

- Performed statistical, qualitative, and quantitative analyses.
- Reviewed documents and data to identify trends and patterns.
- Maintained up-to-date records of research activities and results for future reference.

Teacher's Assistant, 06/2023 - 12/2023
Introduction to Audiology – Pennsylvania State University

- Held office hours weekly as a source of additional support to students.
- Oversaw students in the classroom and supplied support when needed.
- Graded assignments and reported individual progress to the teacher.

Event Coordinator, 01/2022 - 01/2023
Phi Sigma Sigma – Pennsylvania State University

- Coordinated schedules and timelines for events.
- Managed event logistics and operations.
- Brainstormed and implemented creative event concepts and themes.

Barista, 01/2022 - Current
Starbucks – State College, PA

- Pleasantly interacted with customers during hectic periods to promote a fun, positive environment.
- Controlled line and crowd with quick, efficient service.
- Maintained regular and consistent attendance and punctuality.