SATURDAY, FEBRUARY 19, 2022

- LaDIVA: A neurocomputational model providing laryngeal motor control for speech acquisition and production
  - H. Weerathunge, G. Alzamendi, G. Cler, F. Guenther, C. Stepp, M. Zanartu
- Impact of social condition on vocal communication and neurobiology in the Pink1-/- rat model
  - C. Broadfoot, C. Lenell, C. Kelm-Nelson, M. Ciucci
- Dynamics of neural oscillations in children who stutter performing a non-speech motor task
  - V. Caruso, A. Hampton Wray, E. Lescht, Y. Liu, E. Garnett, S. Chang
- Preliminary 6-month speech outcomes from deep brain stimulation of the subthalamic nucleus in Parkinson's disease
  - K. Stipancic, K. Tjaden, A. Rohl, D. Corcos, C. Patterson, J. Greenlee
- Speakers adapt to opposing auditory perturbations of phonemically-identical vowels within a single word
  - B. Parrell, C. Niziolek, M. Bugg, K. Zarnott, C. Naber
- **IMPLICATIONS FOR MOVEMENT DISORDERS AND REHABILITATION**
  - Scott Frey
- Enhancing motor speech fluency: OPTIMAL theory implications
  - Gabriele Wulf
- Changes in speech rate induced by delayed auditory feedback under different speaking conditions
  - M. Heyne, M. Tardif, A. Petitjean, E. Hacker, V. Pennetti, J. Bohland
- Adaptation to auditory perturbations of consonant duration in syllable onset is modulated by phonemic category boundaries
  - R. Karlin, B. Parrell

POSTER SESSION 3

K. Stipancic, K. Tjaden	Lexical characteristics of the Speech Intelligibility Test
K. Bunton, B. Story	Nasal coupling area and the perception of stop versus nasal consonants in female and child talkers
S. Gutz, K. Stipancic, J. Green	Validity of commercial Automatic Speech Recognition (ASR) for assessing speech severity and intelligibility in individuals with ALS
K. Nagle, V. Buscarnera, E. Ketterer, A. Mira, T. Eadie	Effects of noise type on speech intelligibility & perceived listening effort for tracheoesophageal speech
R. Utianski, J. Duffy, H. Clark, J. Stierwalt, H. Botha, F. Ali, K. Josephs	Understanding rate modulation abilities in progressive apraxia of speech
P. Rong, O. Hansen, L. Heidrick	Rate-elicited adaptation of speech motor control scheme and its differential effect on acoustic performance in individuals with ALS – A multimodal investigation
J. Vuolo	Manual rhythmic sequencing and coordination in children with childhood apraxia of speech
H. Cheng, A. Buchwald	Examining individual predictors of transfer of learning in non-native consonant cluster learning
M. Eshghi, J. Green, A. Haenssler, Z. Scheier, M. Keegan, A. Clark, K. Burke, J. Berry, K. Connaghan	Acoustic quantification of respiratory function in amyotrophic lateral sclerosis
T. Knowles, V. Parsa	Controlled effects of face coverings on speech acoustics, intelligibility, and perceived listener effort
R. Lester-Smith, B. Story	Source-filter interactions in simulated respiratory and laryngeal tremor
K. Connaghan, H. Rusiewicz, C.Daley	The Effect of manual gestures on vowel acoustics of sung German vowels
Y. Liu, S. Treleaven, C. Johnson, H. Chow, M. Hampton Wray, S.E. Chang	Error-related neural response scales with cerebellar gray matter volume in children who stutter
G. Moya-Gale, A. Wisler, M. McAuliffe, E. Levy	Acoustic and intelligibility baseline features in Spanish speakers with dysarthria
A. Kawamura, C. Nightingale, G. Moya-Gale, L. Ramig, T. McAllister	Investigating the use of crowdsourcing for perceptual ratings of voice quality in speakers with hypokinetic dysarthria

T. Mahr, K. Hustad	Lexical predictors of single-word intelligibility in young children's speech
C. Cheng, N. Young, K. Teplansky, G. Kurteff, R. Samlan, T. Mau, J. Wang	Fricative production in laryngeal, electrolaryngeal, and tracheoesophageal speech
C. Dromey, A. Jackson	Articulatory kinematic effects of different rate cueing techniques

POSTER SESSION 4

T. Knowles, G. Badh	The effect of face coverings on clear and loud speech
J. Sidtis, D. Sidtis	Cerebellar role in pause duration variability with deep brain stimulation in Parkinson's disease
R. Utianski, H. Clark, J. Stierwalt, J. Duffy, H. Botha, F. Ali, K. Josephs	Patient and care partner ratings of communication participation in progressive motor speech disorders
E. Wang, M. Grigos	Listener perceptions of speech intelligibility in children with apraxia of speech
O. Murton, K. Connaghan, M. Eshghi, M. Maffei, J. Green	When is a voice measure not a voice measure?
A. Hilger, K. Dunne-Platero, T. Fahey, M. Esver	Impact of speech naturalness, intelligibility, and referral to speech therapy on quality of life in cerebellar ataxia
E. Maas, P. Mahoney, G. DeDe, F. Kohen	Effects of feedback type in script training for Apraxia of Speech (AOS)
J. Case, E. Wang, M. Grigos	The Multi-Component Rating Scale: A novel measure of motor-based deficits in childhood apraxia of speech
E. Maas, G. Potkovac, G. DeDe, F. Kohen	Self-controlled vs. Clinician-controlled feedback in treatment for apraxia of speech
A. Neel, J. Richardson, J. DeSanctis, L. Bennett, S. Banks, C. Bernick	Auditory-perceptual profiles of speech in professional fighters
T. Fahey, A. Hilger, M. Esver	The impact of American Sign Language parameters on intelligibility
N. Khaloueipour, K. Reilly	Vowel and stop consonant cues produced by adult Persian speakers with Down syndrome and healthy speakers
S. Keller, E. Maas	Self-reported communication attitudes of children with childhood apraxia of speech
D. Guarin, Y. Yunusova	The role of articulatory kinematics in the assessment of bulbar dysfunction in ALS
J. Berry, M. Johnson	Novel articulatory-acoustic learning in dysarthria: Effects on movement smoothness

LaDIVA: A neurocomputational model providing laryngeal motor control for speech acquisition and production

H. Weerathunge, G. Alzamendi, G. Cler, F. Guenther, C. Stepp, M. Zanartu

Motor speech disorders can be the result of both neural and biomechanical impairments, with interactions that are not always clear. This lack of clarity is exacerbated in individuals with vocal symptoms given the inherent difficulties with measurement and access of the larynx. Further, a unified computational framework that quantitatively integrates physiologically relevant models of phonation with neural speech motor control for studying typical and pathological voice production has not been developed. Here, we introduce LaDIVA, a novel neurocomputational model with physiologically based laryngeal motor control. We combined the DIVA model (an established neurological framework of speech motor control) with the extended body-cover model (an established physics-based vocal fold model). The resulting integrated model (LaDIVA) was validated by comparing its simulations with behavioral responses to auditory vocal fundamental frequency (fo) feedback perturbations collected in typical young adults. LaDIVA demonstrated capability to simulate different modes of vocal motor control, ranging from short-term (i.e., reflexive) and long-term (i.e., adaptive) auditory feedback paradigms, to generating prosodic contours in speech.

Simulations showed that LaDIVA's vocal motor control displays properties of motor equivalence, i.e., it robustly generated compensatory responses to reflexive vocal fo perturbations with varying initial laryngeal muscle activation levels leading to the same output. LaDIVA can be used to expand the understanding of the physiology of human phonation and enable, for the first time, the investigation of causal effects of neural motor control in the fine structure of the vocal signal.

Impact of social condition on vocal communication and neurobiology in the Pink1-/- rat model

C. Broadfoot, C. Lenell, C. Kelm-Nelson, M. Ciucci

Social interactions and quality of life are negatively impacted by communication deficits, anxiety, and depression in Parkinson Disease (PD). The central hypotheses for this study were that social isolation further contributes to vocal degradation and that enhancing social conditions will slow the progression of vocal deficits, improve cognitive ability, and decrease overall levels of anxiety, and anhedonia, an indicator for depression in a Pink1-/- rat model of PD. Further, we hypothesized that alterations in social condition would change the neurochemical content in the ventral tegmental area (VTA), which is associated with social reward processing and degenerates in PD. Results revealed decreases in anhedonia (depression) and elevations in dopaminergic and serotonergic metabolites as a function of social enrichment. The results of this work indicate that disruptions in social environment can impact behavioral function as well as changes to neural pathology in this PD rat model.

Dynamics of neural oscillations in children who stutter performing a non-speech motor task

V. Caruso, A. Hampton Wray, E. Lescht, Y. Liu, E. Garnett, S. Chang

Stuttering is a speech disorder associated with deficits in the sensorimotor system. We investigated the dynamics of neural processing with EEG during a non-speech motor task in children who stutter (CWS) and children who do not stutter (CWNS). We measured changes in movement-related oscillatory power, phase-locking, and inter-channel phase synchronization (a measure of functional connectivity). Although behavioral performance was comparable across groups, a complex pattern of oscillatory dynamics differentiated CWS and CWNS. CWS displayed reduced modulation of power and phase synchronization over the left hemisphere, reduced left-lateralization of phase locking to movement initiation at slow frequencies (delta) and increased interhemispheric phase synchrony in the delta and beta bands. These results indicate atypical cortical dynamics in stuttering during non-speech motor processing, even in the absence of behavioral performance differences.

Preliminary 6-month speech outcomes from deep brain stimulation of the subthalamic nucleus in Parkinson's disease

K. Stipancic, K. Tjaden, A. Rohl, D. Corcos, C. Patterson, J. Greenlee

Subthalamic nucleus (STN) deep brain stimulation (DBS) is utilized to effectively manage global motor symptoms of Parkinson's disease (PD), yet speech outcomes following STN-DBS implantation are highly variable. Factors predicting speech prognosis are not well understood, in part, because studies rarely employ a comprehensive set of rigorous speech outcome metrics, and the majority of studies lack a non-surgical control group. The absence of a non-surgical comparison group limits conclusions concerning the distinct effects of disease progression versus electrical stimulation on speech outcomes. Using a prospective design, the overarching goal of this work is to define the role of STN in speech production, delineate the impact of STN-DBS on speech using a variety of well-defined speech outcome metrics, and to identify factors leading to these speech outcomes. Here we report preliminary speech acoustic and perceptual outcomes for two matched groups of participants with PD tested off-medication: non-surgical controls (N=4) who were examined at baseline and at a 6-month follow-up, and surgical participants (N=14) who underwent bilateral STN-DBS implantation. Speech outcomes for the surgical group were obtained at presurgical baseline and 6 months post-surgery with DBS stimulation both ON and OFF. Notable trends include 1) no change in intelligibility from baseline to 6-months for either group; 2) an increase in perceived listening effort from baseline to 6-months for the surgical group with DBS ON as well as slowed articulation rate, shallower diphthong F2 slopes, and enhanced acoustic contrast for monophthong vowels and fricatives. These preliminary findings suggest that the slowed articulation rate accompanying STN-DBS ON stimulation facilitates some aspects of segmental articulation. Slowed rate, however, may contribute to an increase in perceived listening effort.

Speakers adapt to opposing auditory perturbations of phonemically-identical vowels within a single word

B. Parrell, C. Niziolek, M. Bugg, K. Zarnott, C. Naber

Speakers adapt their feedforward motor commands in response to external perturbations of auditory feedback, but because this phenomenon has been largely investigated using monosyllabic words, the scope of adaptation remains poorly understood: how general or local are the changes to motor representations? Here, we test the specificity of speech adaptation by applying opposing auditory perturbations to phonemically-identical vowels within the same word ("bedhead"). Speakers adapted to both perturbations, simultaneously adjusting their productions of [ɛ] towards /æ/ for one syllable and towards /ɪ/ for the other syllable, and maintained these changes in a washout period with normal auditory feedback. These results demonstrate that sensorimotor learning in speech is not a global transformation of forward predictive models for a single word; rather, these patterns are consistent with either syllable-specific adaptation or dynamic adaptation of word-level motor plans.

- **IMPLICATIONS FOR MOVEMENT DISORDERS AND REHABILITATION**
  - Scott Frey

Enhancing motor speech fluency: OPTIMAL theory implications

Gabriele Wulf

Speech disorders often involve significant client distress with dysfunctions in coordination, planning, and execution of movements. In 2016, Gabriele Wulf Wulf and Rebecca Lewthwaite published the Optimizing Performance Through Intrinsic Motivation and Attention for Learning (OPTIMAL) Theory. OPTIMAL theory centers on the conditions of practice that facilitate efficient goal-action coupling for motor performance and learning. Key theory factors include: (a) support for client autonomy, (b) enhanced expectancies for future performance, and (c) an external focus of attention. Pairing motor practice with conditions that support autonomy, boost confidence and outcome expectations, and focus their attention on movement effects facilitates more skillful movement. These conditions align thoughts, motivation, attention, and neural and neuromuscular systems to the performer's goals. I will give an overview of OPTIMAL theory and important research underpinnings that establish behavioral impacts of subtle motivational and attentional inputs and instructions.

Changes in speech rate induced by delayed auditory feedback under different speaking conditions

M. Heyne, M. Tardif, A. Petitjean, E. Hacker, V. Pennetti, J. Bohland

Delayed auditory feedback (DAF) causes changes to speech output, including reductions in speech rate, increased vocal intensity and pitch, and fluency errors. Here we report preliminary results from a large-scale investigation of the effects of DAF on speech sequencing. We assess how speech rate is affected by increasing delay for three different tasks (repetition of sentences, and 3- and 4-syllable sequences under pseudorandom delays of 0-250 ms) that present increasing load on a speech output buffer. We hypothesized that DAF would lead to increasing rate reductions for the higher-load tasks. Results from 16 speakers confirm that delayed feedback drives speech rate reductions. However, our preliminary analyses did not find an interaction effect, so we could not support the hypothesis that delay impacts speech output differently in these three tasks. Ongoing work will refine estimates of speech rate and increase sample size to add clarity to task-dependence in speech output under DAF.

Adaptation to auditory perturbations of consonant duration in syllable onset is modulated by phonemic category boundaries

R. Karlin, B. Parrell

Recent studies have shown that speakers adapt temporal aspects of speech in response to auditory perturbations, but there are conflicting findings regarding syllable onset consonants. We present an altered auditory feedback study that examines the role of phonemic category boundaries in temporal adaptation of syllable onsets. We used two consonant targets: voice onset time (target words "tapper", "copper") and fricative duration (target words "sapper", "shopper"), where the duration of these targets signals voicing category. Participants received cross-category temporal perturbation (shortening) on /t, s/ and within-category perturbation (lengthening) on /k, ʃ/. Participants adapted more for consonant targets that received cross-category perturbation than for targets with within-category perturbation. The results suggest that feedback monitoring of speech timing, at least in syllable onsets, may be more concerned with categorical errors than within-category variability.

Lexical characteristics of the Speech Intelligibility Test

K. Stipancic, K. Tjaden

Lexical characteristics of speech stimuli can significantly impact intelligibility. However, the lexical characteristics of the widely-used Speech Intelligibility Test (SIT) have not been examined. Using an extant database of 78 speakers, comprised of 32 neurologically healthy controls, 30 speakers with multiple sclerosis (MS), and 16 speakers with Parkinson's disease (PD), percent correct intelligibility scores were obtained for the SIT. We also calculated word frequency and neighborhood density for each word in these sets of SIT sentences (78 sets x 11 sentences = 858 sentences). We examined the distribution of these lexical variables across the SIT sets, performed correlation analyses for intelligibility and each lexical characteristic, and compared results to previous work reporting an association between intelligibility and lexical characteristics. Three primary findings emerged: 1) There was considerable variability in lexical characteristics both within and across the large corpus of SIT sentences. Such variability in lexical characteristics across stimuli has the potential to significantly affect intelligibility that is not attributable to differences in speech motor control. 2) There was not a robust association between overall intelligibility and lexical characteristics. Overall, patients with dysarthria secondary to MS and PD presented with very mild speech impairments, which may explain the lack of robust associations in this cohort of speakers. 3) We replicated findings from a previous study demonstrating differences in intelligibility for speakers with PD across levels of high and low neighborhood density and word frequency. Overall, lexical characteristics have the potential to influence intelligibility and to this point, have not been considered in our most popular intelligibility tests.

Nasal coupling area and the perception of stop versus nasal consonants in female and child talkers

K. Bunton, B. Story

Stop and nasal consonants are both produced by occluding the vocal tract in the labial, alveolar, or velar regions in American English, and then releasing the constriction. One difference in production is that the oral occlusion during a nasal consonant coincides with a lowering of the velum, creating a port that couples the main vocal tract to the nasal passages, allowing for air flow and sound to exit at the nares. Although coupling is required for a nasal consonant to be produced, the minimum magnitude of the coupling that is necessary for a listener to identify a consonant as a nasal rather than a stop is not well understood. Story and Bunton (Motor Speech Conference, 2020) have shown that for a male speaker, listeners identify a consonant as a stop when the velopharyngeal coupling area is less than 0.035-0.057 cm2 depending on place of articulation and the vowel. The specific aim of this study is to determine the nasal port coupling area at which the perception of a stop consonant switches to its nasal cognate for female and child talker.

Validity of commercial Automatic Speech Recognition (ASR) for assessing speech severity and intelligibility in individuals with ALS

S. Gutz, K. Stipancic, J. Green

There is an increasing interest in using automatic speech recognition (ASR) systems for evaluating impairment severity or speech intelligibility in speakers with dysarthria. We assessed the clinical validity of ASR for indexing both sentence-level transcription intelligibility and clinician-rated speech severity in individuals with amyotrophic lateral sclerosis (ALS). Human transcription intelligibility achieved better accuracy than ASR when indexing clinician-rated speech severity. Although related, human transcription-derived intelligibility and ASR performance had a non-linear association. Internal reliability metrics were worse for ASR than human transcription, particularly for typical and mildly impaired severity groups. Results indicated that ASR may be poorly equipped for early detection of speech impairment and for fine-grained speech impairment stratification, measured both as clinical speech severity and as sentence-level transcription intelligibility. Although human and ASR transcription were correlated, ASR should not be used as a one-to-one proxy for speech intelligibility derived from orthographic transcription or clinician severity ratings. Overall, findings suggest that current off-the-shelf ASR systems have limited utility for grading clinical speech impairment in speakers with ALS.

Effects of noise type on speech intelligibility & perceived listening effort for tracheoesophageal speech

K. Nagle, V. Buscarnera, E. Ketterer, A. Mira, T. Eadie

After total laryngectomy, speakers often report difficulty communicating in noisy settings. This study examines how different noise types may affect speech intelligibility compared to perceived listening effort (PLE) in speakers who use tracheoesophageal (TE) speech. Specifically, the purpose of this study was to determine how multitalker babble (MTB) and steady-state speech-shaped noise (SSN) affect intelligibility and PLE in highly intelligible speakers using TE speech. Ten TE speakers provided audio recordings. DATA COLLECTION IS ONGOING. SLP graduate student listeners (N=30) rate PLE and transcribe sentences for speech samples across 3 conditions (quiet, MTB and SSN at +6dB SNR) in an online perceptual paradigm. Differences in PLE for stimuli with equally high intelligibility would provide further evidence of PLE as a unique and functional outcome measure for individuals with disordered speech and voice. Clinical implications will be provided.

Understanding rate modulation abilities in progressive apraxia of speech

R. Utianski, J. Duffy, H. Clark, J. Stierwalt, H. Botha, F. Ali, K. Josephs

Progressive apraxia of speech (PAOS) is a devastating syndrome often characterized by predominant phonetic or prosodic disturbances. Perceptual description of PAOS is the gold standard for diagnosis, but is considered to have mixed reliability. An objective marker of motor speech functioning might improve diagnostic accuracy. The purpose of this study was to understand the absolute and relative abilities of patients with motor speech disorders (MSD) to modulate rate. Patients completed a Modulated Rate Elicitation Task in which they were asked to repeat stimuli “as fast/slow as you can.” Durations for the entire response served as a crude measure of rate. Limited data from patients with PAOS, hypokinetic and spastic dysarthria, and controls establish that all participants could modify rate in the cued directions but to varying degrees. It is plausible that rate modulation in a cued task is a useful marker for diagnosis. Patient capacity to modify rate also may inform interventions.

Rate-elicited adaptation of speech motor control scheme and its differential effect on acoustic performance in individuals with ALS – A multimodal investigation

P. Rong, O. Hansen, L. Heidrick

This study determined how voluntary speaking rate reduction impacted the control scheme and performance of speech produced by individuals at different stages of bulbar involvement in ALS and healthy speakers. Jaw muscle activities, jaw kinematics, and speech acoustics were recorded during a habitual and a slow speech task, using a multimodal paradigm. Eight muscular-kinematic features were extracted to characterize the speech motor control scheme. These features were then clustered into two latent factors reflecting the coordination and integration of speech production. Eight acoustic features were derived as measures of speech performance. Voluntary rate reduction elicited a less cohesive, more localized, and less

integrative control mode, which differentially affected speech performance across groups, with the early and control groups exhibiting primarily negative effects, the intermediate group exhibiting a significant positive effect, and the late group showing minimal change.

Manual rhythmic sequencing and coordination in children with childhood apraxia of speech

J. Vuolo

Though childhood apraxia of speech (CAS) is a motor speech disorder, several theories posit that CAS reflects a broad impairment in domain general mechanisms such as timing, rhythm, and procedural learning. We investigated rhythmic sequencing and coordination in 4- to 12-year-old children with CAS and children with typical development (TD). Children imitated clapping and tapping an easier and a more difficult rhythm. Dependent measures include mean number of beats, pause marking, correct pause location, and overall accuracy. We predict that children with CAS will perform less accurately than children with TD overall. We also expect to observe an interaction between group and coordinative complexity, with children with CAS showing disproportionate difficulty in the clapping tasks. These findings will be interpreted in relation to current theoretical accounts of CAS.

Examining individual predictors of transfer of learning in non-native consonant cluster learning

H. Cheng, A. Buchwald

While studies of speech motor learning distinguish between performance during practice (i.e., acquisition) and performance after practice, including a retention period and transfer of learning, relatively little is known about whether performance during acquisition predicts individual differences observed in retention and transfer. Here we examined this relationship in the context of non-native cluster learning. The results showed that performance during acquisition for participants trained on the voiceless stop-stop clusters predicted the magnitude of transfer to the untrained voiced counterparts. However, for individuals learning to produce the more complex voiced stop-stop clusters, no relationship was found between performance during acquisition and transfer of learning. This work raises critical questions about the relationship between improvement during acquisition and the magnitude of transfer, and whether the complexity of the learning target mediates that relationship.

Acoustic quantification of respiratory function in amyotrophic lateral sclerosis

M. Eshghi, J. Green, A. Haenssler, Z. Scheier, M. Keegan, A. Clark, K. Burke, J. Berry, K. Connaghan

In this study, we aimed to identify acoustic correlates of respiratory function in individuals with ALS who typically demonstrate evidence of respiratory insufficiency at some stage of the disease. Mean vital capacity (VC) and audio recordings of various speech samples were collected from 42 individuals with ALS using the Beiwe smartphone research platform. The respiratory subscale scores on the ALSFRS-R was used to classify participants into asymptomatic (scores equal to 12, n=13) and symptomatic (scores below 12, n=29) respiratory groups. An array of acoustic measures that target speech duration, rate, pause, voice and intensity were used to examine the viability of using acoustic-based methods as proxies for the measure of VC in quantifying the status of the respiratory function. Duration, rate, and pause measures demonstrated moderate to strong association with mean VC, suggesting potential acoustic-based quantification of respiratory function in individuals with ALS.

Controlled effects of face coverings on speech acoustics, intelligibility, and perceived listener effort

T. Knowles, V. Parsa

Speech produced in 9 face mask conditions were recorded in quiet and in noise. Low, mid, and high-range frequency amplitudes were extracted to quantify the effects of the masks on the long-term average spectrum. Recordings in noise were played to naive listeners via an online crowd-sourcing platform, who were asked to transcribe what they heard and rate how effortful it was for them to understand. Acoustic and perceptual outcomes were modelled as a function of mask type. Perceptual outcomes were additionally modelled as a function of the acoustic measures.

All masks were transcribed with poorer accuracy and rated as more effortful than no mask. The combination of an N95 and

face shield led to the poorest perceptual outcomes. Results indicated that soft mask materials, but not transparent shields, were associated with attenuation of mid-range frequencies. Mid, but not low or high-range frequencies, predicted intelligibility. Findings have implications for mask communication strategies.

Source-filter interactions in simulated respiratory and laryngeal tremor

R. Lester-Smith, B. Story

Vocal tremor is a neurogenic voice disorder characterized by rhythmic oscillation of structures within the respiratory, laryngeal, pharyngeal-oral, or velopharyngeal-nasal subsystems. These oscillations produce modulation of the fundamental frequency and intensity and result in a “shaky” voice. Standard acoustical assessments of voice cannot differentiate the physiological sources of intensity modulation because microphone signals represent a combination of the source and filter features. However, a recent study indicated that comparisons of neck-surface vibration sensor and microphone signals differentiated source and filter features in vocal vibrato. Further investigation is warranted to determine if comparisons of neck-surface vibration sensor and microphone signals might differentiate physiological sources of modulation in vocal tremor and advance clinical assessment of voice. The purpose of this study was to determine if the relationships between the rate and extent of fundamental frequency and intensity modulation in vibration sensor and microphone signals differ for simulated respiratory and laryngeal sources of modulation. A kinematic model of the vocal folds and wave reflection models of the trachea, pharynx, and oral cavity were used to simulate respiratory and laryngeal tremor with a 5 Hz modulation rate and a range of modulation extents. Custom-written Praat scripts will be used to analyze the rate and extent of fundamental frequency and intensity modulation in simulated neck-surface vibration and microphone signals. The results of this study may have implications for clinical assessment of vocal tremor. Because the success of medical treatment of vocal tremor (i.e., laryngeal botulinum toxin injection) varies based on the physiological sources of tremor, identification of respiratory and laryngeal sources may help guide individualized and targeted interventions.

The Effect of manual gestures on vowel acoustics of sung German vowels

K. Connaghan, H. Rusiewicz, C.Daley

Interventions to facilitate accurate non-native speech production often aim to modify placement of the oral articulators. Manual mimicry and gesture production can elicit changes to articulator placement based upon entrainment between the manual and speech motor systems. The current project was designed to explore the effect of manual gesture-based instruction on the acoustics of non-native vowels produced by singers. Twenty-four vocal performance students were randomly assigned to one of three instructional groups (i.e., no gesture, view gesture, view and do gesture) and audio-recorded producing German vowels. Vowel formants were extracted and compared pre- and post-instruction and across instruction type. Significant changes ($p<.02$) to the 2nd formant and to the distance between the first two formants were observed only within the gesture conditions. These preliminary findings support gesture-based instruction as a promising approach to facilitate non-native sound production.

Error-related neural response scales with cerebellar gray matter volume in children who stutter

Y. Liu, S. Treleaven, C. Johnson, H. Chow, M. Hampton Wray, S.E. Chang

Several theoretical models suggested that stuttering is linked to altered error monitoring during speech production. Supporting this assertion, adults who stutter exhibit enhanced error-related negativity (ERN) response, a negative deflection event-related potential used to quantify neural manifestations of error monitoring. Meanwhile, cerebellar hyperactivity and altered cerebellar anatomy is reported in stuttering, which may be related to altered error monitoring during speech. In this study, we examined cerebellar morphology in conjunction with ERN activity measured during a Go/No-Go task in children who stutter (CWS) compared to fluent controls. Larger ERN amplitude associated with greater cerebellar gray matter volume in CWS but not controls, suggesting normal error monitoring function may rely on greater cerebellar volume in CWS. In sum, preliminary results indicated that CWS may require greater gray matter growth to present with comparable error monitoring to fluent controls.

Acoustic and intelligibility baseline features in Spanish speakers with dysarthria

G. Moya-Gale, A. Wisler, M. McAuliffe, E. Levy

Parkinson's disease (PD) affects approximately one million individuals in the United States and more than six million individuals worldwide. Hispanics are the largest minority group in the U.S. and they exhibit the highest incidence of the disease in the country. Recently, there has been an increase in the investigations of how acoustics and intelligibility may be differentially affected in dysarthria depending on the native language of the speaker and the listener. The aim of this preliminary study was to examine selected baseline acoustic speech parameters likely to be affected in Spanish speakers with dysarthria as well as their speech intelligibility and that of healthy controls. Understanding of these variables is the first step in predicting how these features may influence models of speech intelligibility in this language. Results replicated findings from studies cross-linguistically for some of the variables but not others. Implications for Spanish dysarthria are discussed.

Investigating the use of crowdsourcing for perceptual ratings of voice quality in speakers with hypokinetic dysarthria

A. Kawamura, C. Nightingale, G. Moya-Gale, L. Ramig, T. McAllister

A new direction in perceptual rating of speech data is online crowdsourcing, where researchers gather feedback from large samples of untrained listeners under conditions that are less controlled than typical laboratory studies. Previous work by Nightingale et al. (2020) validated the use of crowdsourcing to obtain ratings of speech clarity for speakers with hypokinetic dysarthria secondary to Parkinson Disease (PD), but we are aware of no previous research assessing the ability of crowdsourced listeners to rate voice quality. This study aims to assess whether crowdsourced perceptual ratings of voice quality in patients with PD correlate with acoustic measures obtained in a companion study (Moya-Galé et al., in preparation), and whether that study's findings of change over the course of treatment will be replicated in rating data from untrained listeners. In light of recent shifts toward greater use of online data collection, this research could inform clinical and research practices.

Lexical predictors of single-word intelligibility in young children's speech

T. Mahr, K. Hustad

Speech perception is a probabilistic process, integrating bottom-up and top-down sources of information, and the frequency or structure of a word can predict how well it is perceived. Therefore, instead of asking how intelligible speakers are, it is also important to ask how intelligible individual words are. For this study, we measured the intelligibility of 165 children between 30 and 47 months in age on 38 different words and asked how words varied in intelligibility and whether word-level characteristics (frequency, phonotactic probability, motor complexity) predicted intelligibility. An item-response analysis showed that there was considerable variation in individual words with a reliable effect of frequency such that higher frequency words were more intelligible. Implications for disordered speech are discussed.

Fricative production in laryngeal, electrolaryngeal, and tracheoesophageal speech

C. Cheng, N. Young, K. Teplansky, G. Kurteff, R. Samlan, T. Mau, J. Wang

Patients who have a laryngectomy primarily use esophageal, tracheoesophageal (TEP), and electrolaryngeal (EL) speech for voice restoration. Like normal laryngeal speech, TEP speech is pulmonary driven, whereas EL speech is not. Besides, laryngeal speech and TEP speech are produced during exhalation, while EL users also inhale during speech production. This study aimed to investigate how different power sources and speech breathing patterns could impact the production of fricatives, which require turbulent airflow through articulatory constrictions. Based on the preliminary results, we found that the fricatives in laryngeal and TEP speech share similar temporal and spectral features. However, the fricatives in EL speech are significantly shorter and demonstrate low-frequency peaks on spectrums, suggesting a decreased airflow through constrictions. Further analysis is needed with larger sample size and data other than audio recordings, such as intra-oral pressure and oral airflow.

Articulatory kinematic effects of different rate cueing techniques

C. Dromey, A. Jackson

The current study examined the change in articulatory patterns when speakers were asked to increase and decrease their speaking rate by matching metered and rhythmic audio recordings and by matching metered and rhythmic audiovisual recordings. There were 10 participants, five male and five female, ranging in age from 20 to 36 with a mean age of 25. Participants spoke the sentence "Don't fight or pout over a toy car" under rhythmic, metered, fast and slow conditions and in response to audio only or audiovisual models, resulting in eight speaking conditions: audio metered fast, audiovisual metered fast, audio metered slow, audiovisual metered slow, audio rhythmic fast, audiovisual rhythmic fast, audio rhythmic slow, and audiovisual rhythmic slow. Each participant had five sensors glued to their tongue, teeth and lips and articulatory movements were recorded with an NDI Wave electromagnetic articulograph. Ten tokens of the target utterance were analyzed for duration and Spatiotemporal Index (STI). STI was then computed for the vertical movements of the tongue, jaw and lower lip, as well as lip aperture in order to measure variability of speech movements over multiple sentence repetitions. Stroke metrics based on the speed history of the articulators were also computed in order to reveal average kinematic features of articulatory gestures, or the individual. movement strokes that occurred between successive speed minima in running speech. Statistical analysis revealed that STI measures did not change significantly in response to the different rate conditions. This study demonstrated that in neurotypical individuals, articulatory patterns including stroke count, onset speed, peak speed and hull area changed significantly in faster or slower speech. Additionally, the results revealed that both metered and rhythmic cues and both audio and audiovisual cues are effective in decreasing and increasing speaking rate without significantly impacting the STI (i.e., consistency) of articulatory movements. Therefore, it may be that a speaker's efforts to match the audio and audiovisual cues in real-time more significantly affected articulation patterns than whether cues were rhythmic, metered, audio or audiovisual.

The effect of face coverings on clear and loud speech

T. Knowles, G. Badh

In light of the COVID-19 pandemic, the Center for Disease Control recommended that individuals wear face masks to prevent the spread of airborne viral particles and reduce disease transmission. Previous research suggests that many types of face coverings attenuate higher frequency speech information and negatively impact speech intelligibility. It is not presently known how altering one's style of speech may be able to overcome these effects. The purpose of this study was to quantify the effects of two distinct face masks (surgical and KN95) on spectral properties of speech produced in three speaking styles: habitual, clear, and loud.

Seventeen healthy talkers read aloud sentences in three mask and three speech conditions. Spectral moments and spectral tilt were extracted from the long-term average spectrum of each utterance and were chosen due to their sensitivity to speaking style and the potential filtering properties of the mask. Acoustic variables were modelled as a function of mask, speech style, and their interaction.

Both masks significantly attenuated higher frequency energy in the speech signals, with the greatest attenuation observed for the KN95 mask. Both clear and loud speech styles were associated with flatter spectral tilt for all mask conditions, indicating speakers were able to overcome this attenuation by altering their speech. However, individual participant behavior suggests that while most speakers produced flatter tilt in loud speech compared to their baseline without a mask, fewer did so with clear speech.

Results indicate that loud, rather than clear speech may be a more reliable strategy for overcoming the low-pass filter effects of face masks. Findings have implications for the effects of face masks on the speech of individuals with speech or voice disorders. Further work will explore relationships between these acoustic effects, speech intelligibility, and listener effort.

Cerebellar role in pause duration variability with deep brain stimulation in Parkinson's disease

J. Sidtis, D. Sidtis

Parkinson's disease and its associated dysarthria are generally viewed as the result of a basal ganglia disorder. However, the role of cerebellar dysfunction is increasingly being considered as a contributor to Parkinsonian symptoms. Several repetitive speech tasks were recorded from individuals with Parkinson's during measurements of regional cerebral blood flow using Positron Emission Tomography. Individuals were studied twice: once during therapeutic deep brain stimulation of the subthalamic nucleus, once without stimulation. Pause variability was calculated across the repetitive speech tasks. With the stimulation off, regions in both the left and right cerebellar hemispheres contributed to pause variability. With stimulation, several anatomic levels of the cerebellar hemispheres had increased blood flow. Regions in the left but not right cerebellar hemisphere contributed to predicting pause variability with stimulation. These results suggest that cerebellar function may interact with the basal ganglia to affect the speech of individuals with Parkinson's disease.

Patient and care partner ratings of communication participation in progressive motor speech disorders

R. Utianski, H. Clark, J. Stierwalt, J. Duffy, H. Botha, F. Ali, K. Josephs

Prior studies have shown communication-related participation restrictions in patients with degenerative disease do not always match practitioner judgment of disease severity. The purpose of this study was to compare patient and care partner ratings of such restrictions. Patients with progressive MSDs and their care partners were asked to complete the Communication Participation Item Bank (CPIB), which is a 10-question survey and the primary measure in this study. The preliminary data (n=6) have not revealed a clear trend in discrepancies between patient and care partner reported communication-related participation restrictions. With more data it may be possible to parse whether the nature or severity of the MSD predicts a discrepancy. This study lays the foundation for future research to study the impact of patient and care partner ratings on the utilization and effectiveness of compensatory speech strategies.

Listener perceptions of speech intelligibility in children with apraxia of speech

E. Wang, M. Grigos

Children diagnosed with apraxia of speech (CAS) are often described as having poor speech intelligibility. Motor-based interventions, such as Dynamic Temporal and Tactile Cuing (DTTC), aim to improve movement gestures during speech production. Whether such intervention enhances speech intelligibility remains unknown. The present study explored whether speech intelligibility changed pre- to post-DTTC treatment and was maintained after a 6-week period. Naïve listeners (N=120) orthographically transcribed single words produced by children with CAS (ages 2;5-3;11) across three time points (baseline, post-treatment, maintenance). Changes in speech intelligibility were examined, as was the inter- and intra-rater reliability of listener ratings. Results were interpreted with respect to changes in intelligibility over a motor-based treatment period, and on measures of inter- and intra-rater reliability between and within listeners. The theoretical and clinical implications are discussed.

When is a voice measure not a voice measure?

O. Murton, K. Connaghan, M. Eshghi, M. Maffei, J. Green

In this study, we investigate how impairments in non-phonatory subsystems confound acoustic measures of phonatory function. We hypothesize that (1) increased pausing in an utterance reduces CPP and (2) increased nasality increases CPP in speakers with ALS. Voice-filtered CPP was computed based on automatically extracted voiced segments from read sentences. Trained listeners provided perceptual judgments of vocal and hypernasality severity. Preliminary results show that voice-filtered CPP is better correlated with vocal severity than non-filtered CPP is ($r = -0.74$ and -0.58 respectively). These findings indicate that removing pauses from continuous speech is a best practice for improving the construct validity of CPP as a voice measure. Later findings will investigate the relationship between CPP and degree of hypernasality, and the resulting limits of CPP as an indicator of vocal severity in hypernasal speakers.

Impact of speech naturalness, intelligibility, and referral to
speech therapy on quality of life in cerebellar ataxia
A. Hilger, K. Dunne-Platero, T. Fahey, M. Esver

The speech impairment resulting from ataxia, or damage to the cerebellum, typically affects speech naturalness more than intelligibility (Blaney & Hewlett, 2007; Brendel et al., 2013), resulting in potential under-referral to speech therapy and underestimation of the effects of dysarthria on quality of life. This presentation will discuss a study which (1) surveyed individuals with ataxia about their access to, experiences in, and satisfaction with speech therapy; (2) measured communication participation and quality of life; and (3) assessed speech naturalness and intelligibility via recorded speech samples.

The results of this study will answer the following questions: (1) Does speech naturalness and/or intelligibility positively correlate with quality of life? (2) Does access to speech therapy services correlate with improved quality of life? We predict that there is no relationship between quality of life, intelligibility, and naturalness. In other words, quality of life can be impacted in ataxia regardless of dysarthria severity. However, we also predict that quality of life will be positively related to referral to speech therapy. The significance of this research is that it will provide insight into factors that influence referral for speech therapy in cerebellar ataxia that will hopefully result in greater referral and access to speech therapy across demographic factors. Improving referral and access to evidence-based speech therapy will, in turn, improve the chance for greater quality of life and communicative participation.

Effects of feedback type in script training for Apraxia of Speech (AOS)
E. Maas, P. Mahoney, G. DeDe, F. Kohen

This study examines the effects of feedback type (knowledge of results [KR] vs. knowledge of performance [KP]) in treatment for apraxia of speech (AOS). Despite its potential relevance to treatment for AOS, feedback type has not been studied in treatment for AOS. In this multiple-baselines alternating treatments single-case experimental design, script training was provided to one person with AOS in two conditions (KR and KP). Outcome measures were words-per-minute (WPM) and percent script words correct (PSC). KR and KP conditions did not differ for PSC but WPM revealed an advantage for KP over KR. Both KR and KP conditions resulted in greater learning than the control condition for WPM, replicating the efficacy of script training for AOS.

The Multi-Component Rating Scale: A novel measure of
motor-based deficits in childhood apraxia of speech
J. Case, E. Wang, M. Grigos

Childhood apraxia of speech (CAS). is a complex pediatric motor speech disorder. Existing measures of speech production accuracy are challenged by the ability to maintain good inter-rater reliability while capturing motor speech deficits in CAS. The Multi-Component Rating Scale (MCRS) was created to measure characteristic speech deficits of CAS, including segmental accuracy, maintenance of word structure, prosodic accuracy, and movement transitions. This study examined the inter-rater reliability of the MCRS across speech-language pathologists with expertise in motor speech disorders when rating probe words produced by 2-4 year old children with CAS. In addition, it explored the degree to which the MCRS correlated with measures of speech accuracy (Percent Phoneme Correct, 3-point Rating Scale). Theoretical and clinical significance of this measure to more precisely measure motor speech deficits in CAS will be discussed.

Self-controlled vs. Clinician-controlled feedback in treatment for apraxia of speech
E. Maas, G. Potkovac, G. DeDe, F. Kohen

This study investigates the role of feedback control (self-controlled vs. clinician-controlled) in treatment for apraxia of speech (AOS). A robust principle of motor learning is that self-controlled feedback enhances learning compared to clinician-controlled feedback. Despite its potential relevance to motor speech disorders, there are no published studies of feedback control in treatment for AOS. In this alternating treatments single-case experimental design, script training was provided to

one person with AOS in two conditions: self-controlled and clinician-controlled feedback. Outcome measures were words-per-minute (WPM) and percent script words correct (PSC). There were no effects on WPM, but for PSC, scripts receiving self-controlled feedback showed greater learning than scripts receiving clinician-controlled feedback. Treated scripts in both conditions showed greater learning than untreated scripts.

Auditory-perceptual profiles of speech in professional fighters
A. Neel, J. Richardson, J. DeSanctis, L. Bennett, S. Banks, C. Bernick

Professional fighters exposed to repeated head injury (RHI) are at risk for degenerative neurologic decline. Boxing has long been associated with dysarthria, but comprehensive descriptions of speech characteristics associated with RHI in fighters are limited to a few case studies (McMicken et al., 2011; Berisha et al., 2017). As part of a larger study dedicated to identifying speech and language biomarkers of RHI in professional fighters, we obtained auditory-perceptual ratings of speech (overall severity, articulation, voice, resonance, prosody, and fluency) in passages read aloud by 49 boxers and 11 healthy control participants in the Professional Fighters Brain Health Study (PFBHS; Bernick et al., 2013). We aim to identify speech biomarkers for early identification of neurogenic impairment and to align behavioral and neuroimaging findings in fighters exposed to RHI.

The impact of American Sign Language parameters on intelligibility
T. Fahey, A. Hilger, M. Esver

Due to the scarcity of research regarding intelligibility in sign language, particularly American Sign Language (ASL), the goal of this study was inspired to further knowledge on determining the relationships between parameters in ASL (handshape, palm orientation, movement, location, and expressions/nonmanual signs) and intelligibility. In addition, this study is a precursor to understanding how movement disorders such as Parkinson's Disease or cerebellar ataxia affect ASL intelligibility. Since movement disorders affect coordination and control of arm movement, we expect that ASL intelligibility would be significantly impacted. This study will investigate ASL intelligibility relative to the parameters of sign, which in the future, can be used in further research to investigate the impact of movement disorders on ASL production.

Vowel and stop consonant cues produced by adult Persian
speakers with Down syndrome and healthy speakers
N. Khaloueipour, K. Reilly

Despite the growing literature on speech impairments in Down Syndrome (DS), little is known about speech difficulties in non-English DS speakers whose native language phonemes possess different spectrotemporal characteristics. The present study evaluates production of consonant-vowel- consonant utterances in adult speakers of Persian to determine whether this language's similar inventory of stop consonants, but reduced vowel inventory affects the distinctiveness of these sounds in speakers with DS. Participants in this study consisted of 13 adult Persian speakers with DS and 20 aged-matched healthy Persian speakers. Voice onset times (VOTs) and formant transitions are used to evaluate voicing and place of articulation contrasts in Persian stop consonants and vowel F1 and F2 are analyzed to evaluate Persian vowel contrasts. Findings of the VOT analysis indicate reductions in the voicing distinction in the DS group. Analyses formant transition and vowel formant data are ongoing.

Self-reported communication attitudes of children with childhood apraxia of speech
S. Keller, E. Maas

Much of the research literature on childhood apraxia of speech (CAS) has focused on understanding, diagnosing, and treating the impairment, rather than the broader impact of CAS. The present study addresses the Personal Factors component of the WHO model. Specifically, we examined self-reported communication attitudes of 12 children with CAS enrolled in an intensive speech-focused intervention, using two validated questionnaires (CAT & KiddyCAT). We compared their scores to the questionnaires' typically-developing norms. We also examine relationships with CAS severity, parent perception of

communicative participation, and change over a brief period. Preliminary findings reveal that older but not younger children with CAS are more likely to have negative self-perceptions about their speech. Additional data will be available at the conference and will be discussed relative to assessment and intervention for CAS. [funded by R01 DC017768 and Temple University Diamond Research Scholarship]

The role of articulatory kinematics in the assessment of bulbar dysfunction in ALS

D. Guarin, Y. Yunusova

The overall speaking rate has been a preferred measure to track bulbar ALS progression, establish disease severity, and plan communication interventions in a clinical setting. Although it has been interpreted as a measure of bulbar disease severity, it is known to be affected by other factors such as reading ability/ education, cognitive status, and respiratory impairment. Emerging work suggests that articulatory kinematic features might provide important complementary information to phrase duration measures that are used for speaking rate estimation.
In this study, we aimed to extend our previous results and demonstrate that video-based articulatory kinematic features obtained with a simple 3D camera during the production of short sentences can differentiate healthy controls from patients with ALS at different (early and late) stages of bulbar decline.

Novel articulatory-acoustic learning in dysarthria: Effects on movement smoothness

J. Berry, M. Johnson

This study examines changes in articulatory movement smoothness in individuals with and without dysarthria as they learn novel articulatory movement patterns under different auditory feedback conditions. Novel speech movement patterns are elicited using an electromagnetic articulography-driven articulatory speech synthesizer to provide real time auditory feedback. Participants are asked to imitate unfamiliar phrase-level phonetic sequences. Changes in movement smoothness as a function of speaker state (typical vs. dysarthria), auditory feedback condition (perturbed or not), and learning phase are examined. Results suggest that perturbations to the auditory-acoustic working space can bolster pattern learning and that some talkers with dysarthria may present with greater novel articulatory pattern learning proficiency than neurotypical talkers.