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# Presence of Late 8 Phonemes among Adolescents and Young Adults with Down syndrome

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# PRESENCE OF LATE 8 PHONEMES AMONG ADOLESCENTS AND YOUNG ADULTS WITH DOWN SYNDROME

by

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A Thesis
Submitted in Partial Fulfillment of the Requirements for the
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THESIS APPROVAL

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TITLE: PRESENCE OF LATE 8 PHONEMES AMONG ADOLESCENTS AND YOUNG ADULTS WITH DOWN SYNDROME

MAJOR PROFESSOR: Dr. Valerie Boyer

The purpose of this study was to describe the phonetic repertoire of late 8 phonemes among adolescents and young adults with Down syndrome and then determine the relationship between age and presence of the latest developing phonemes as well as their impact on intelligibility. This study also described the stimulability profile for those late 8 phonemes that were produced in error. The Arizona Articulation and Phonology Scale was administered to individuals with Down syndrome between the ages of 12 – 21;11 to obtain a phonetic profile. Among those participants included in the study, on average, 87.5% of the late 8 phonemes were present. Seven of eight participants were stimulable for all phonemes that were misarticulated. Results did not indicate a significant correlation between either age or intelligibility and the presence of late 8 phonemes.

ACKNOWLEDGMENTS

I would like to thank my advisors for encouraging me to research a topic that ignited my interest in the field of speech-language pathology. Thank you to Drew Middleton for his involvement with this project. To my family who have supported and encouraged me throughout this process. Finally, I would like to thank each of the participants who participated in my project; this would not have been possible without you.

# DEDICATION

This thesis is dedicated to my family and friends with Down syndrome. To Griffin, my cousin, and the original Teen Tastics crew – Sam, Carter, Dylan, Logan, Julia, Emily, and Nate – I will be forever grateful for your friendship.

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# CHAPTER 1

## INTRODUCTION

Currently, there is limited data related to the phonological development of individuals with Down syndrome, specifically the late 8 phonemes: /ʃ, θ, s, z, ð, l, r, ʒ/. The latest developing phonemes make up a third of all consonantal speech sounds and, in theory, their presence or absence in a person's phonetic repertoire is of significant concern when considering speech intelligibility and communicative effectiveness. Among the Down syndrome population, poor speech intelligibility is commonly reported. It is thought to be influenced by an incomplete phonetic repertoire which is impacted by several factors including hearing loss, anatomical and physiological differences, and exposure to a less complex linguistic environment (Stoel-Gammon, 2001).

Roberts et al. (2005) reported that only 38% of the latest developing phonemes were produced accurately among a sample of participants with Down syndrome (2005). This study does not attempt to answer the question of why the phonetic repertoire of individuals with Down syndrome may be incomplete, rather, its goal is to determine if the late 8 phonemes are present among an older sample of participants. Knowledge of the presence of these phonemes among individuals with Down syndrome could assist speech-language pathologists in providing continued intervention to improve articulatory precision and intelligibility.

# CHAPTER 2

# LITERATURE REVIEW

Individuals with Down syndrome typically experience persistent speech disorders which significantly impact intelligibility into adulthood. A review of the literature revealed characteristics of the disorder which impact intelligibility; however, there is a lack of research related to the phonological acquisition among adolescents and adults with Down syndrome.

## Down syndrome Etiology

According to the Centers for Disease Control (CDC), Down syndrome is the most common chromosomal disorder occurring in 1 of every 700 births; its incidence has increased by 30% from 1979 to 2003. Down syndrome is the result of one of three different genetic variations: trisomy 21, translocation, and mosaicism. Trisomy 21 occurs when there are three copies of all or a partial amount of the genes of the 21st chromosome and is the cause of 95% of instances of Down syndrome. Translocation is the process whereby a third copy of the 21st chromosome is attached to a nearby chromosome including chromosome 13, 14, 15, 21, or 22. Pair translocation occurs in less than 5% of cases of Down syndrome. Mosaicism occurs when not all cells contain a third copy of the 21st chromosome (Patterson & Lott, 2008). All three variations impact the development of individuals with Down syndrome.

## Intelligibility

Phonological development and the acquisition of the entire English phonetic repertoire is an important marker for speech intelligibility. The results of a study conducted by Kumin (1994) found that 95% of parents of an individual with Down syndrome experienced some difficulty with intelligibility. Participants included 937 parents of children with Down syndrome aged birth to over 40 years old. When specifically looking at the ages of 13-21, per parent report, 54% of

the individuals were frequently misunderstood and 43% were sometimes misunderstood. Overall, 97% of the 13-21 aged individuals had some difficulty being understood. Of the parents of children age 13-21, 85% reported difficulty with articulation and 59% reported irregular rate of speech. Across all ages and groups, 80% of parents reported that their child had difficulty with articulation on the oromotor skills portion of the survey (Kumin, 1994).

Wilson, Abbeduto, Camarata, and Shriberg (2019) analyzed 45 conversational samples of individuals with Down syndrome, age 10 to 20 years, collected from three separate studies to determine the presence of speech and motor speech disorders. As defined in the study, persistent speech errors are, "age inappropriate speech sound distortions," while speech delay is defined as, "age-inappropriate speech sound deletions and/or substitutions (Wilson et al., 2019, p. 789)." The speech samples were narrowly transcribed. At the time of assessment, 2.2% of participants had normal speech, 4.4% had persistent speech errors while 93.3% met criteria to be diagnosed with a speech delay. Of those participants with a speech disorder, 26.7% had a speech motor delay, 37.8% had childhood dysarthria, 11.1% had childhood apraxia of speech, and 22.2% had both childhood dysarthria and childhood apraxia of speech. The most common dysarthria subtype associated with the speech errors of participants with childhood dysarthria was ataxic. This subtype is characterized by excess and equal stress, irregular articulatory breakdown, and inaccurate articulation (Wilson et al., 2019).

**Phonological Acquisition and Down syndrome**

It is hypothesized that reduced intelligibility in Down syndrome may be caused by an incomplete phonetic repertoire (Stoel-Gammon, 2001, p. 97). In turn, phonological acquisition and development are posited to be impacted by several features of Down syndrome which include hearing loss, anatomical and physiological differences, and a degraded developmental

linguistic environment (Stoel-Gammon, 2001, pp. 93-95).

**Hearing Loss**

Individuals with Down syndrome frequently experience hearing loss as a result of recurrent otitis media with effusion (OME). Nightengale, Yoon, Wolter-Warmerdam, Daniels, and Hickey (2017) described hearing loss in a sample of 308 individuals with Down syndrome age one day to 22 years as occurring among 36% of the participants. Of those included in the study, 29.7% experienced transient hearing loss, which occurred when the participants obtained an abnormal hearing evaluation. Considering all participants included in the study, 38.6% reported a history of otitis media with effusion. Austeng, Akre, Overland, Abdelnoor, Falkenberg, and Kvaerner (2013) reported that, among children born with Down syndrome in Norway in 2002, 38% suffered from otitis media with effusion consistent with results from Nightengale et al. (2017). The hearing level of individuals with otitis media with effusion was on average 33.4 dB HL; conversely, the hearing level of individuals with no otitis media with effusion was 21.7 dB HL.

Lau, Ko, & Cheng (2015) found that, among 50 individuals with Down syndrome with a mean age of 11.7 years, 36% of the participants had hearing loss as determined through brainstem auditory evoked potentials. Of those with hearing loss, 72.2% (only one child had a history of OME) were conductive loss and 27.8% were sensorineural while only 26% of the participants suffered from hearing loss as reported by caregivers on a questionnaire. Raut et al. (2011) reported that, among newborns who received a hearing screening, 34.1% were diagnosed with hearing loss, while 82% of individuals who received a full audiologic evaluation were diagnosed with hearing loss. The average age for diagnosis of hearing loss was 6.6 months. By the first year of life, prevalence of hearing loss decreased to 34.1%.

**Anatomical and Physiological Differences**

There are several anatomical and physiological differences which are postulated to impact phonological acquisition among individuals with Down syndrome. Results of a study completed by Barnes, Roberts, Mirrett, Sideris, and Misenheimer (2006) indicated a direct correlation between oral structures and nonverbal IQ. Overall, compared to participants with Fragile X, a genetic disorder that leads to cognitive impairments, and a typically developing group, individuals with Down syndrome presented with the least developed oral structures. Compared to boys with Fragile X and typically developing peers matched for nonverbal IQ, the boys with Down syndrome received lower oral structure and function scores, along with lower speech function tasks (Barnes et al., 2006, p. 912). For the boys with Down syndrome, oral structures were rated more highly than their speech functions meaning that, while structures were developed, speech functioning was not guaranteed. The boys with Down syndrome exhibited the most atypical oral structure and were less able to complete functional oral motor tasks as compared to speech tasks. The structures that deviated most significantly from typical included the lips, tongue, and velopharyngeal structure (Barnes et al., 2006, p. 912). Stoel-Gammon (2001) reported that individuals with Down syndrome have a smaller oral cavity, fewer facial muscles, and a tongue that is large relative to available space in the oral cavity. According to Kent & Vorperian (2013), "[The] craniofacial anatomy of individuals with Down syndrome is characterized by a compact mid and lower-face skeleton, a tongue of average size, and a palate that is high and often shelf-like (p. 185)." As reported by Stoel-Gammon (2001), these anatomical and physiological differences lead to decreased articulatory ability thereby decreasing overall intelligibility.

**Linguistic Environment**

A crucial aspect of the acquisition and development of language is social interaction which provides developing children with language models. Evidence suggests that interactions between parents and children with Down syndrome are less complex than with typically developing peers. The speech directed towards children with Down syndrome is higher in pitch, atypical in prosody, and more grammatically incomplete (Stoel-Gammon, 2001). In a study conducted by Laws & Bishop (2003), in which children with Down syndrome were compared to children with specific language impairment, grammar understanding was impaired but receptive vocabulary was a relative strength. With regards to expressive language, both the specific language impairment group and Down syndrome group were impaired when compared to the control group. In general, language skills of participants with Down syndrome are not commensurate with nonverbal mental age. When tested for expressive and receptive vocabulary, individuals with Down syndrome were not different from mental-age matched controls meaning vocabulary acquisition keeps pace with nonverbal mental age (Laws & Bishop, 2003, p. 1335).

Cleland, Wood, Hardcastle, Wishart, and Timmins (2010) reported variability among individuals with Down syndrome across measures of speech, language, and cognition; however, results suggested that expressive language was delayed relative to cognitive abilities and receptive language. The investigators noted that some variability in the scoring of expressive language could be due to the highly unintelligible speech of the participants with Down syndrome (Cleland et al., 2010, p. 90). With regards to language scores, the scores did not correlate with verbal mental age which means that language delays are not the result of cognitive impairment. Similarly, there was no correlation between intelligibility and any cognitive or

language measures (Cleland et al., 2010).

**Phonetic and Phonological Inventory**

As reported in Shriberg, Austin, Lewis, McSweeny and Wilson (1997), the speech sounds of the English language can be divided into three developmental categories: early 8, middle 8, and late 8. The earliest developing phonemes include /m, b, j, n, w, d, p, h/. The middle developing phonemes include /t, ŋ, k, g, f, v, ʧ, ʤ/. Typically, the latest developing phonemes are /ʃ, θ, s, z, ð, l, r, ʒ/. The division of the 24 phonemes into these developmental subgroups allows for more precise analysis of speech sound errors than is possible when considering percentage of consonants correct (PCC) alone (Shriberg et al., 1997).

Roberts et. al (2005) conducted a study in which the phonological skills of boys with Down syndrome were compared to boys with Fragile X syndrome along with a typically developing group of boys matched for nonverbal mental age. The sample included: 32 males with Down syndrome, age 4.3-12.9 years; 50 males with Fragile X syndrome, age 3.2-14 years; and 33 typically developing males, age 2.1-6.2 years (pp. 982-983). The Sounds-in-Words portion of the Goldman-Fristoe Test of Articulation – Second Edition was administered to all participants. Responses were filmed and 23% of the collected speech samples underwent interobserver scoring. Across groups, the average agreement between the two raters when utilizing broad transcription was 92.2%; Down-syndrome-specific agreement slightly lower at 91.4% (Roberts et al., 2005, p. 983). Results of the study indicated typically developing participants produced the “early-8” with 95% accuracy, “middle-8” with 87% accuracy, and “late-8” with 78%. Males with Fragile X syndrome produced the early, middle, and late developing phonemes with 91%, 86%, and 65% accuracy, respectively. For the participants with Down syndrome, the early developing consonantal phonemes with 71% accuracy, the middle

developing phonemes with 55% accuracy, and the late developing phonemes with 38% accuracy (Roberts et al., 2005, pp. 985-986). Compared to the Fragile X syndrome and typically developing groups, participants with Down syndrome obtained the lowest accuracy across all three developmental phonetic subgroups. In regard to proportion of whole-word proximity (PWP), no significant difference was found between those with Fragile X syndrome (90%) and typically developing participants (93%), while the Down syndrome group obtained a significantly lower score of 75%. The researchers note that there was considerable individual variability noted between participants in the Down syndrome group (Roberts et al., 2005).

Smith and Stoel-Gammon (1983) compared the production of stop consonants of typically developing participants to those with Down syndrome aged 3 to 6 years. Results of the study indicated that typically developing children produced stop consonants in the initial and final positions with 91% and 67% accuracy, respectively. For the Down syndrome group, the accuracy of stop consonants in the initial and final position of words was 67% and 57%, respectively. It has been found that individuals with Down syndrome present with delayed phonological acquisition, with more phonological processes, which generally improved over time (Smith & Stoel-Gammon, 1983).

Bleile and Schwartz (1984) compared the phonetic inventories of three individuals with Down syndrome with ages between 3.3 to 4.5. Speech samples were recorded during observation sessions which occurred three times per week for twelve weeks, with each session lasting roughly 10 minutes. Accuracy for the early, middle and late 8 (excluding /ʒ/) consonants were as follows: 75% 37.5%, and 8.3%, respectively. Stoel-Gammon (1980) collected speech samples from four individuals with Down syndrome age 3.8 to 6.25 throughout six half hour sessions where the participant was engaged with either the examiner or family members. Of the early and

middle 8 consonants, 94% were acquired, while 61% of the late 8 consonants were acquired.

In a longitudinal study conducted by Kumin, Council, and Goodman (1994), emphasis was placed on emergence of phonemes rather than mastery due to the variability of production of phonemes among individuals with down syndrome. Data was recorded from 60 individuals with Down syndrome, age 9 months to 9 years, who were enrolled in a university clinic. Utilizing data provided within the study, the mean age at which the early, middle, and late 8 (excluding /ʒ/) consonants emerged was: 2.75, 3.5, 3.5. On average, the early 8 emerged among 83% of the participants, while the middle and late 8 emerged in 57% and 58% of participants, respectively. The researchers also reported significant variability among participants regarding the age at which phonemes emerged. For example, /d/ emerged in four participants between 0-11 months of age, while the same phoneme did not emerge until 96-107 months of age for another participant (Kumin, Council, & Goodman, 1994).

A study conducted by Dodd (1976) found that individuals with Down syndrome produced fewer speech errors when a word was produced imitatively, as compared to spontaneous productions. More errors were produced by individuals with Down syndrome than severely subnormal Down syndrome group and normally developing group matched for mental age (Dodd, 1976).

Barnes et al. (2009) reported a PCC and PWP of a group of boys with Down syndrome, age 4.5-16, to be 71.6% and 86.4%, respectively, which was significantly lower compared to participants Fragile X only, Fragile X with co-occurring autism spectrum disorder, and typically developing participant groups. For reference, typically developing peers included in the study received PCC and PWP scores of 89.7 and 95.4, respectively. According to Shriberg, Austin, Lewis, McSweeny, and Wilson (1997), conversational speech and PCC are positively correlated.

**Disorder vs Delay**

It has been suggested that the speech production of individuals with Down syndrome is inconsistent (Dodd, 1976). Dodd and Thompson (2001) sought to define speech disorder among children with Down syndrome when compared to children who produce inconsistent articulations and found that the speech production of children with Down syndrome is disordered rather than delayed. The study contained 15 children with Down syndrome and 15 children with a phonological delay characterized by inconsistent errors. Results of the study indicated there was no difference in the inconsistency of productions between either group at the word level. Results indicated that 67% of words were pronounced inconsistently in the Down syndrome participants. According to Burt et al. (1999), children with normal phonological acquisition produce words with less than 10% inconsistency while those with delayed phonological acquisition produce 20% of selected words inconsistently. Kumin, Council, and Goodman (1994) report, “it is clear that the order of emergence of sounds in children with Down syndrome does not appear to follow the same order as the norms for acquisition of typically developing children (p. 300).” Dodd and Thompson (2001) suggest that the deficit may originate within the speech-processing chain.

# CHAPTER 3

# METHODOLOGY

The purpose of this study was to describe the phonetic repertoire of the late 8 phonemes among a sample of adolescents and young adults with Down syndrome. This study was intended to address the following research questions.

1. What is the phonetic profile of the late 8 phonemes in a group of adolescents and young adults with Down syndrome?
2. What is the stimulability profile of the late 8 phonemes in a group of adolescents and young adults with Down syndrome?
3. What is the median number of late 8 phonemes present in a group of adolescents and young adults with Down syndrome?
4. Does age correlate with production of the late 8 phonemes?
5. Does production of late 8 phonemes correlate with speech intelligibility?

## Operational Definitions

1. Down syndrome – A chromosomal disorder caused by a third complete or partial copy of the 21st chromosome in all or some of the cells of an individual (Patterson & Lott, 2008). Diagnosis of Down syndrome of all participants was confirmed through parental report.

2. Phonetic inventory – The phonetic repertoire of the individuals with Down syndrome collected through administration of the Arizona-4.

3. Late 8 phonemes – As described by Shriberg et al. (1997), the late 8 phonemes include /ʃ, θ, s, z, ð, l, r, ʒ/.

4. Stimulability – Assessment of participants ability to repeat phonemes which were initially produced in error or omitted. Measured with the Speech Imitation Context Tasks (SICT) of the

Arizona-4.

**Participants**

Participants were recruited from two regional Down syndrome achievement centers. The program director from each site circulated the cover letter included in Appendix A to the parents of participants who were between the ages of 12 and 21;11. Interested parents responded to the email and scheduled a time for their son or daughter to participate in the study. Participants with history of craniofacial anomaly and hearing impairment were excluded from this study. Hearing impairment was measured by those participants wearing hearing instrumentation. A description of the study and methods was provided to all participants and their families. Both participants and a parent/guardian signed authorizing consent for participation. All participants included in the study were diagnosed with Down syndrome. Nine participants were recruited for the study from regional Down syndrome achievement centers though the data from one participant was excluded due to non-compliance throughout the data collection session. The participants ranged in age from 13 years, 6 months to 19 years, 7 months.

**Data Collection**

The SIUC Human Subjects Committee has approved the methods utilized to collect data for this study. The Arizona Articulation and Phonology Scale – Fourth Revision Word Articulation subtest was administered to all participants (Fudala & Stegall, 2017). The Arizona-4 is a standardized test of articulation and phonology that contains a normative sample from 18 months to 21 years, 11 months. Per the Arizona-4 manual, individuals with severe disabilities were excluded from normative sampling; however, if a student was diagnosed with a mild disability and he or she spent most of the school day in the general education classroom, they were included (Fudala & Stegall, 2017, p. 110). Reliability of the Arizona-4 was measured with

the split-half method to determine internal consistency demonstrated reliability coefficients of .88 or higher across all subtests and age groups. Interrater reliability was high for both word and sentence articulation tasks with coefficients of .90 and .85 (Fudala & Stegall, 2017, pp. 119-124). The Goldman-Fristoe Test of Articulation 2, and the companion Khan-Lewis Phonological Assessment Second Edition, are well known speech-sound assessment tools which both correlate with the Arizona-4. The Sounds-in-Words subtest of the GFTA-2 correlated significantly with the Word Articulations subtest of the Arizona-4 at the level of r=.77 (standardized sample) and r=.85 (clinical sample) (Fudala & Stegall, 2017, p. 132).

The Word Articulation subtest includes 46 target words which include 67 target sounds: initial consonants, final consonants, and vowels. If sounds were misarticulated during the Word Articulation task, the SICT was administered. The supplemental task includes 16 phonemes and phoneme blends which should be mastered at 90% by age 4, as determined by the normative data collected for the Arizona-4. Each phoneme and/or blend includes nine nonsense words which were administered for the misarticulated sounds.

The Arizona-4 was individually administered to all participants by the principal investigator. During administration, the principal investigator and participant were seated approximately two feet apart at a table. Responses to the Word Articulation subtest were audio recorded using a Sony IC Recorder which was placed 18-24 inches in front of the participant on top of the table. Data collected from the Word Articulation test was then utilized to assess the presence of late 8 phonemes. Responses from the entire Word Articulation test were then scored to determine the participant's Speech Intelligibility Interpretation Value (SIIV).

**Inter-Rater Reliability**

The principal investigator and a graduate student trained in broad phonetic transcription

listened to and transcribed all recorded samples included in data analysis (n=8). Inter-rater reliability was provided for all 67 target sounds included in the Word articulation subtest of the Arizona-4 for each of the eight participants. When a difference in transcription occurred, the recording was replayed and a consensus was reached.

**Data Analysis**

All data was collected and analyzed utilizing either Microsoft Excel or SPSS. A primary aim of the study was to provide descriptive statistics of the late 8 phonetic repertoire of participants, as well as the profile of stimulability. Pearson correlations were utilized to measure if relationships were present between the variables of age or intelligibility—calculated from SIIV— and presence of late 8 phonemes.

# CHAPTER 4

# RESULTS

## Phonetic Profile of Late 8 Phonemes

What is the phonetic profile of Late 8 phonemes among a sample of adolescents and adults with Down syndrome?

Data from the administration of the Arizona-4 was utilized to create phonetic profiles of the participants in the sample. A majority of the phonemes assessed with Arizona-4 are scored based on an initial and final position within the word. For the purposes of this project, a phoneme was considered present if it was produced accurately in either the initial or final context. Those phonemes that were not present were either omitted entirely or significantly distorted. The phonemes / ʃ, s, ð, l/ were present in the repertoire of 100% of participants. As outlined in figure 1, the presence of remaining late 8 phonemes among participants were as follows: /θ, ʒ/ at 87.5% , /z/ at 75%, and /r/ at 50%.

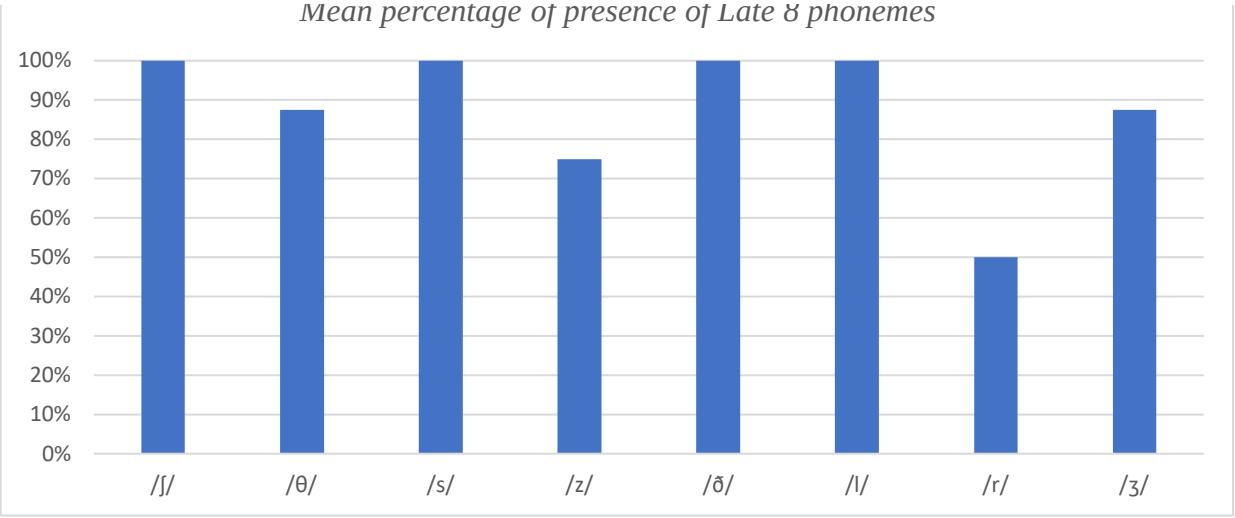


**Figure 1**

*Mean Percentage of Presence of Late 8 Phonemes*

**Stimulability Profile of Late 8 Phonemes**

What is the stimulability profile of Late 8 phonemes present in a sample of adolescents and young adults with Down syndrome?

SICT were administered to those participants who were unable to produce one of the late 8 phonemes during administration of the Word Articulation subtest to assess stimulability for the phonemes. Among those participants who were administered the SICT, all errored productions were stimulable except for participant who was unable to produce /ʒ/ in any context. If stimulable phonemes are considered present in the phonetic repertoire, then the mean presence of the late 8 phonemes among the participants in the sample would be: /ʃ, θ, s , z, ð, l, r, ð/ at 100% and /ʒ/ at 87.5%.

**Table 1**

*Phonetic Profile of Late 8 Phonemes*

| | **Male, 19;7** | **Female, 17;2** | **Male, 15;4** | **Female, 17;4** | **Female; 15;0** | **Female, 15;6** | **Female, 16;11** | **Female, 13;6** | **Mean Presence** |
|---|---|---|---|---|---|---|---|---|---|
| **/ʃ/** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **100%** |
| **/θ/** | **P** | **P** | **S** | **P** | **P** | **P** | **P** | **P** | **87.5%** |
| **/s/** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **100%** |
| **/z/** | **S** | **P** | **S** | **P** | **P** | **P** | **P** | **S** | **75%** |
| **/ð/** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **100%** |
| **/l/** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **100%** |
| **/r/** | **S** | **P** | **P** | **P** | **P** | **S** | **S** | **S** | **50%** |
| **/ʒ/** | **NS** | **P** | **P** | **P** | **P** | **P** | **P** | **P** | **87.5%** |

**Median number of Late 8 phonemes**

What is the median number of Late 8 phonemes present in a sample of adolescents and young adults with Down syndrome?

The median number of late 8 phonemes present in a sample of adolescents and young adults with Down syndrome is seven.

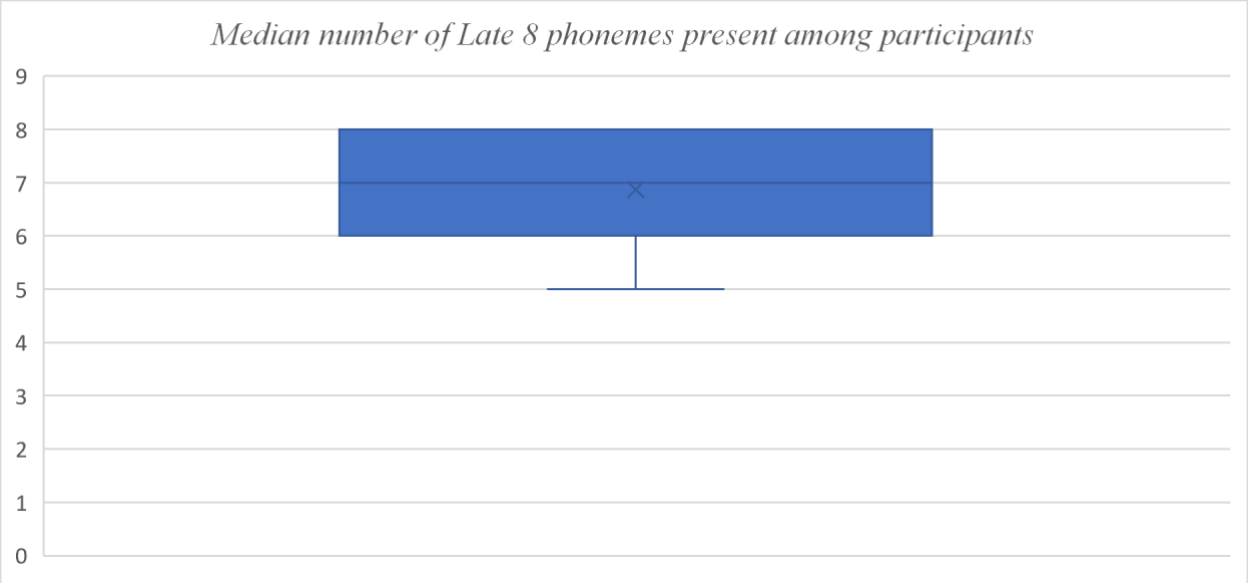


**Figure 2**

*Median Number of Late 8 Phonemes Among Participants*

**Age and presence of Late 8 phonemes**

Does age correlate with the number of Late 8 phonemes present in phonetic repertoire?

A Pearson correlation was calculated to compare age of participants and presence of late 8 phonemes as neither variable was skewed (skewness = .388 and -.488, respectively). The Pearson correlation statistic was calculated, r(6)= -.155, *p* = .715. If participant 1 is considered an outlier, the Pearson correlation statistic is, r(5)= .639, *p*= .122. Neither statistic is significant at the level of the p=.05, as such, there is not enough information to determine whether a correlation exists between age and presence of late 8 phonemes among adolescents and young adults with Down syndrome.

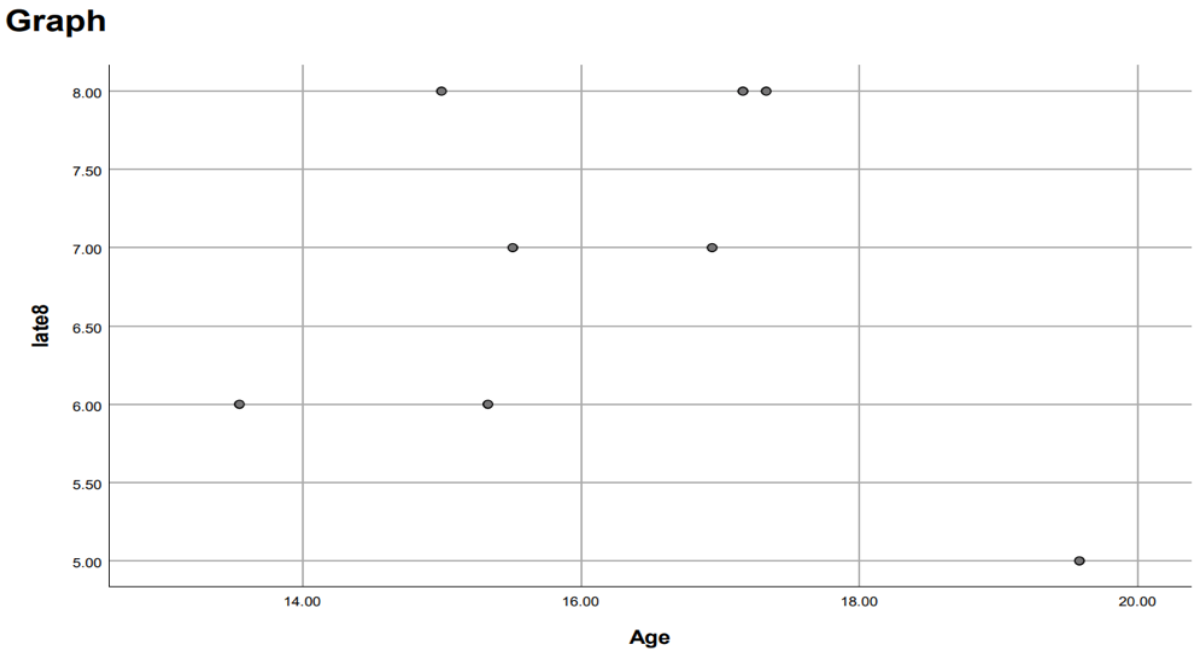


**Figure 3**

*Age of Participants and Presence of Late 8 Phonemes*

**Presence of Late 8 Phonemes and Speech Intelligibility**

Does production of late 8 phonemes correlate with speech intelligibility?

A correlation was calculated between speech intelligibility, determined through the SIIV of the Arizona-4, and presence of late 8 phonemes. The SIIV for one participant was not calculated due to one test item not being administered. Neither variable, intelligibility nor late 8 phonemes, was skewed (skewness= -.639 and -.488) which does not violate the assumption of normality and allowed the use of a Pearson correlation. The statistic was r(5)= .500, *p*= .253 which failed to meet the level of significance of p=.05. This indicates that there was no correlative factor between presence of late 8 phonemes and level of intelligibility.

# CHAPTER 5

# DISCUSSION

Results of the current study indicate that a majority of late 8 class of consonants were present in a sample of adolescents and young adults with Down syndrome with higher accuracies than previously reported in the literature. This is significant in regard to speech intelligibility among individuals with Down syndrome as the data suggests that this population may possess a more complete phonetic repertoire than previously reported. While the metric of PCC was not utilized in this study, Garret and Moran (1992) reported a high degree of correlation between PCC at the word level, obtained from standardized speech assessments, and conversational speech. As stated previously, intelligibility during conversational speech and the measure of PCC are positively correlated (Shriberg et al., 1997). This connection between PCC and conversational intelligibility was previously reported by Roberts et al. (2005).

## Phonetic Inventories

Among the participants included in this study, the late 8 consonants were produced with 87.5% accuracy. Referring to Table 1, there were three participants who were able to produce the latest developing phonemes with 100% accuracy. It is most relevant to review the results of this research study in light of the data provided by Roberts et al. (2005) who found that, among a sample of individuals with Down syndrome from age 4.3-12.9, 38% of the late-developing phonemes were produced accurately. It is also important to note the substantial age range of participants included in Roberts et al. (2005), as the gap demonstrates a rich developmental period that could skew results.

Other studies reported similarly low accuracies for the late 8 but included participants who were much younger than those included in the present study. The accuracies among

participants for the late 8 phonemes in Stoel-Gammon (1980) and Bleile and Schwartz (1984) were 61% and 8.3%, respectively. The differences in presence of late 8 phonemes may be explained by limitations such as a small sample size or drawing participants from a narrow geographic area; however, it is most likely explained by the age of participants included in this study. The results of this study cannot answer the question of phonological disorder or delay among individuals with Down syndrome. The results do, however, provide an interesting lens through which to view the question as nearly all participants were able to produce the late 8 phonemes.

**Stimulability and Intelligibility**

All but one participant was able to spontaneously produce, or was stimulable, for each of the late 8 phonemes. This is relevant because it means that seven of eight participants included in this study were able to produce 100% of the late 8 in some context (word initial, vocalic, cluster, etc.). For clinicians, this indicates that these individuals may demonstrate success with speech therapy as they already possess the phonemes in their repertoire.

Interestingly, one participant exhibited the phonological process of fronting throughout testing until one of the final items was administered. When saying the word “carrots”, the participant stated that all he needed to do was, “pull his tongue back to make those sounds” and then spontaneously and correctly produced each of the words he had previously stated in error. This independent use of a metacognitive strategy is indicative of the benefit of speech intervention and highlights the notion that the improvements can last past the short term.

While those speech sounds affected by the process of fronting are not relevant to the discussion of the late 8 consonants, the sounds were used to calculate the SIIV. Among participants included in this study for whom a SIIV was calculated, the average value was 92.07

out of 100, with a range of 83.4-98. As defined by the Arizona-4, SIIV of 92.07 equates to, "speech is intelligible though noticeably in error" which is similar to the 97% of individuals with Down syndrome age 13-21 classified as having some difficulty being understood (Kumin, 1994).

**Age and Presence of Late 8 Phonemes**

The results of the current study do not indicate there is any correlation between age and presence of late 8 phonemes among individuals with Down syndrome. However, when considering the results of the current study and Roberts et al. (2005), the data suggest that the assertion made by Smith and Stoel-Gammon (1983), that individuals present with delayed phonological acquisition which improves over time, is correct. When comparing the age range and average age of participants included in Roberts et al. (2005) – 4.3 to 12.9; 7.3 – and the present study – 13.5 to 19.6; 16.3 – it appears that age should be predictive of production of the late 8 phonemes given the respective accuracies reported by each study, 38% and 87.5%. Since both studies utilized similar methodologies, and the removal of the oldest participant strengthened the correlative statistic, future studies which include a larger sample size may produce a more significant correlation between age and presence of the late 8 phonemes.

**Limitations and Future Research**

There are a few limitations of this study including sample size and demography of the participant pool which have implications related to the interpretation of data and should be improved in future studies. First, because of the small sample size, the data was influenced significantly by a single participant: the oldest, who produced the least number of late 8 phonemes in spontaneous speech. While he was able to produce five of eight late developing phonemes, his age led to a negative correlative value between the variables of age and presence of the late 8 phonemes which would be mitigated with a larger sample size. Due to the nature of

convenience sampling, a larger proportion of females than males were included in the sample (78% and 22% respectively) with participants clustered near the age of 16. Future studies should attempt to include a greater proportion of male participants and stratify age classes from 13-21;11. Finally, it is out of the scope of the present study to suggest what may be the cause of decreased speech intelligibility among individuals with Down syndrome; however, the data implies an incomplete phonetic inventory may not be the source. Future research should provide data related to the phonological process use of this age range of individuals with Down syndrome, and the relationship to intelligibility, as participants in this study exhibited the use of several of these processes.

# CHAPTER 6

# CONCLUSION

The goal of this research study was to provide data on the phonetic inventory of adolescents and young adults with Down syndrome with a focus on the presence of the late 8 phonemes. Previously, the available data did not extend to the phonetic repertories of young adults with Down syndrome and it was difficult to ascertain whether this population exhibited a phonological delay or disorder. The results of this study cannot be used to prove or disprove either hypothesis but the descriptive information is important, nonetheless, and addresses a gap in the literature.

The Arizona-4 was administered to 8 participants and was utilized to collect data on the presence of the late 8 phonemes, stimulability for those late 8 phonemes produced in error, and create an SIIV. Results of the study indicated that, on average, 87.5% of the late 8 phonemes were present in the phonetic repertoires of included participants. When assessed for stimulability, all participants, except for one, were able to produce each of the late 8 phonemes produced in error. There were no statistically significant relationships between either age or intelligibility and the presence of the late 8 phonemes. However, in light of previous research, it appears that individuals with Down syndrome are able to produce the late 8 phonemes following a significantly delayed developmental trajectory.

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# APPENDICES

# APPENDIX A

## COVER LETTER

Dear Participant:

My name is Aidan Osborne and I am a graduate student at Southern Illinois University Carbondale. For my graduate thesis project, I am examining the acquisition of speech sounds among adolescents and young adults with Down syndrome. Because you are a participant at GiGi's Playhouse and are between the age of 12 to 22 years old, I am inviting you to participate in this research study by completing a standardized articulation assessment.

Administration of the standardized test will require approximately 45 minutes to complete. There is no compensation for participating nor is there any known risk. The gathered data will be available to myself, a graduate assistant, and the thesis committee chair. We will take all reasonable steps to protect your identity. Copies of the project will be provided to my Southern Illinois University-Carbondale thesis committee. If you are willing to participate in my research project, please contact me to reserve a time slot during the aforementioned dates. Participation is strictly voluntary and you may refuse to participate at any time.

Thank you for taking the time to assist me in my educational endeavors. The data collected will provide useful information regarding the acquisition of speech sounds among individuals with Down syndrome.

If you require additional information, have questions, or would like to volunteer to participate in my study, please contact me at the number listed below.

Sincerely,
Aidan Osborne, Graduate Researcher
Phone: 779-537-4922 Email: aidanosborne@siu.edu

Dr. Valerie Boyer, Thesis Committee Chair
Email: Vboyer@siu.edu

This project has been reviewed and approved by the SIUC Human Subjects Committee. Questions concerning your rights as a participant in this research may be addressed to the committee chairperson, Office of Research Compliance, SIUC, Carbondale, IL 62901- 4344. Phone (618)-453-4533. E-mail: siuhsc@siu.edu

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Thesis Paper Title:
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Major Professor: Dr. Valerie Boyer