Examining the Relationships between the Motoric, Phonological Awareness, Rapid Naming, and Speech Sound Abilities of Children

A Thesis submitted

to the Graduate School

Valdosta State University

In partial fulfillment of requirements

for the degree of

MASTER OF EDUCATION

in Communication Disorders

in the Department of Communication Sciences and Disorders & Special Education

of the Dewar College of Education and Human Services

April 2022

Mary Allison Moody

B.S.Ed., Valdosta State University, 2020

This Thesis, "Examining the Relationship between the Motoric, Phonological Awareness, Rapid Naming, and Speech-Sound Abilities of Children," by Mary Allison Moody, is approved by:

Thesis Committee Chair

DocuSigned by:
Matthew Carter
Matthew Carter, Ph.D., CCC-SLP
Associate Professor of Communication Sciences and Disorders
Valdosta State University

Committee Members

DocuSigned by:
Crystal Randolph
Crystal Randolph, Ph.D., CCC-SLP
Associate Professor of Communication Sciences and Disorders
Valdosta State University

DocuSigned by:
Laura L Padgett
Laura Padgett, Ed.D., CCC-SLP
Assistant Professor of Communication Sciences and Disorders
Valdosta State University

DocuSigned by:
Chuck Conner
Chuck Conner, Ed.D.
Assistant Professor of Health Sciences
Valdosta State University

Associate Provost for Graduate Studies and Research

Becky K. da Cruz
Becky K. da Cruz, Ph.D., J.D.
Professor of Criminal Justice
Valdosta State University

Defense Date: April 4, 2022

FAIR USE

This Thesis is protected by the Copyright Laws of the United States (Public Law 94-553, revised in 1976). Consistent with fair use as defined in the Copyright Laws, brief quotations from this material are allowed with proper acknowledgment. Use of the material for financial gain without the author's expressed written permission is not allowed.

DUPLICATION

I authorize the Head of Interlibrary Loan or the Head of Archives at the Odum Library at Valdosta State University to arrange for duplication of this Thesis for educational or scholarly purposes when requested by a library user. The duplication shall be at the user's expense.

Signature ____Mary Allison Moody_________________

I refuse permission for this Thesis to be duplicated in whole or in part.
Signature ____

Abstract

Empirical studies suggest that children with speech sound disorders (SSD) can present with concomitant language and/or literacy impairments. Research also supports the comorbidity of motoric deficits in children with speech and language impairments, but the cumulative research exploring this comorbidity is lacking. The present study investigated the complex relationships that may relate to speech sound abilities, including phonological awareness (PA), rapid automatized naming (RAN), and non-speech-based motoric abilities, among an early school-age sample. Standardized assessments were administered to obtain various measures of each ability. Results indicated significant relationships between speech sound abilities and PA, PA and RAN, GFTA-3 SIW and SIS subtests, and non-speech-based motoric proficiency and speech sound abilities. There was no significant relationship between speech sound abilities and RAN or PA/RAN and non-speech-based motoric abilities. The potential causation of these comorbidities and clinical implications will be discussed.

Acknowledgments

I want to express my sincere appreciation to Dr. Matthew Carter for his unwavering support in helping me grow as an academic researcher. The opportunity to serve as his graduate research assistant helped me understand the importance of academia and how communication sciences and disorders are continually evolving. The courses taught by Dr. Randolph greatly affected my appreciation for the area of speech sound disorders (SSD). I want to thank all the faculty of the Valdosta CSD department for their dedication and support in helping me become a speech-language pathologist. Lastly, I would like to thank my SLP internship mentor, Ms. Kat Bray, for her efforts in providing me with ongoing support in shaping my skills as a clinical practitioner.

Dedication

I proudly dedicate this thesis to my mother and father, who have fostered my academic growth since birth. Without their unwavering support and encouragement, I could not have dedicated hundreds of hours to gathering data and reading journal articles.

Table of Contents

Chapter I

Introduction

Ongoing research is continuously exploring the intricacies of speech sound production, as it is paramount to the field of speech-language pathology. Speech production consists of articulation and phonology. The articulation of speech sounds is a motoric process involving coordinated movements of the articulators and speech systems, whereas phonology is the language domain responsible for outlining the rules associated with the distribution and sequencing of phonemes. Speech sound disorders (SSD) are classified as either motor or language-based. Children with motor-based disorders often have difficulty physically articulating speech sounds, while those with language-based disorders find it especially challenging to understand the phonological system and rules of a language. Children with SSD often present with delayed acquisition of phonemes and lower levels of intelligibility. Approximately 3.8% to 6.4% of 5-to-8-year-old children are classified as having SSD (Shriberg et al., 1999), thus highlighting the prevalence of SSD in the early school-aged population. There is an abundance of literature supporting comorbidity among SSD, language impairments (LI), and reading disorders (RD). Assessment measures may incorporate an extensive evaluation of all communication domains to increase the likelihood of identifying potential concomitant delays. Peer-reviewed studies also suggest a connection between SSD and motoric impairments; however, the underlying relationship between the two is still being established. The present study aimed to further examine the association between phonological processing, speech sound proficiency, and non-speech-based motoric abilities in the early school-age population.

Chapter II

Review of Literature

An Overview of Articulation and Phonology

Articulation

The articulatory component of speech sound production is a systematic and intricate process that involves the rapid movement of the articulators, supported by adequately functioning respiratory, phonatory, and resonatory systems. This process commences by the brain initiating respiration followed by activation and stimulation of the larynx, resonatory cavities, and articulators. The respiratory system supplies the body with adequate airflow for speech production and consists of the lungs, bronchi, trachea, diaphragm, and ribcage. The phonatory system provides voicing for speech and consists of the vocal folds and larynx; the resonatory system aids in uniquely shaping the vocal tract and includes the pharyngeal, oral, and nasal cavities. The articulatory system consists of two types of articulators, which include primary and secondary articulators. Primary articulators are mobile and include the tongue, mandible, lips, and velum; secondary articulators are immobile and include the teeth, hard palate, alveolar ridge, and glottis. Articulation of speech sounds is a motoric process that involves coordinated movements of the articulators and speech systems. Each consonant and vowel have an individualized voicing, place, and manner combination, which molds a distinctive speech sound. When an individual engages in conversational speech, the phenomenon of coarticulation transpires. Coarticulation involves the articulators continually moving into position for other segments of speech. The speech systems are multifaceted and interconnected, each working collaboratively and efficiently, thus, allowing a clear and comprehensible message to be articulated (McLeod & Baker, 2017).

Phonology

Phonology is the domain of language concerned with the rules governing the structure, distribution, and sequencing of speech sounds (Owens, 2016). A phoneme is characterized as the smallest linguistic unit that can signal a difference in meaning, and every language consists of various phonemes. A phoneme is not an individual sound; instead, phonemes formulate a family of sounds often referred to as allophones. Each allophone within a sound family varies slightly from another, but not enough to be classified as another phoneme. Phonology guides phonotactics, which defines the rules associated with phonemes. Indeed, phonotactics outlines the acceptable combinations of phonemes within the initial, medial, and final positions of words. Phonotactics also reveals the rules related to the sequencing and positioning of phonemes; however, these rules are not universal to every language (McLeod & Baker, 2017).

Speech Sound Disorders

"SSDs are characterized by difficulties in forming and stringing together sounds, usually by substituting one sound for another, omitting a sound, or distorting a sound" (Newmeyer et al., 2007, p. 604). Children with SSD often present with delayed acquisition of phonemes and lower levels of intelligibility than typically developing peers without SSD. SSDs consist of two distinct categories, which include disorders that are either language or motor-based. Language-based disorders include phonological and inconsistent phonological disorders. Motor-based disorders include articulation disorders (AD), childhood apraxia of speech (CAS), and childhood dysarthria. An inconsistent phonological disorder, CAS, and childhood dysarthria are less relevant to the current study and are thus not considered in this literature review.

SSDs are classified as either organic or functional. An organic SSD has a known cause, such as otitis media with effusion, Down syndrome, or cleft palate. In contrast, a functional or idiopathic SSD does not have an identifiable cause. There are specific risk and protective factors associated with SSD, which include, but are not limited to, gender, psychosocial behaviors, temperament, maternal education, and family. Children with SSD often have difficulty in one or more of the following areas: perception, motor production, phonological representation, prosody, intelligibility, and acceptability. SSDs can impose adverse effects on the social, educational, occupational, and familial aspects of a child's life, therefore, accentuating the necessity for early clinical identification of SSD in the early school-aged population (McLeod & Baker, 2017).

Phonological Disorder

Children diagnosed with phonological disorders (PD) have difficulty learning the phonological system and comprehending the sound system of a language. Appropriate storage of phonological representations is often considered inadequate, consequently contributing to PD, phonological awareness (PA) deficits, and poor literacy skills (Rvachew & Grawburg, 2006). Children with PD have trouble with phonemic organization, which creates difficulty when attempting to organize and use speech sounds contrastively; therefore, speech errors frequently occur in conversational speech. Speech sound errors occur in a pattern and include more than one sound from a class of sounds. Phonological patterns are generally defined as typical or idiosyncratic. Typical patterns in a young child's phonological system are considered developmentally appropriate; however, idiosyncratic patterns are atypical because of their infrequent occurrence in typically developing children. Early school-age children commonly use typical phonological patterns such as gliding, cluster reduction, and alveolarization; however, patterns should suppress as maturation occurs. If phonological patterns persist beyond the normative age of suppression, then a child is demonstrating characteristics associated with PD. PD is also referred to as a phonological impairment or phonological delay (McLeod & Baker, 2017).

Articulation Disorder

Children diagnosed with AD have difficulty with the motoric processes of speech and articulation of specific speech sounds. Structural impairments such as ankyloglossia, macroglossia, cleft lip, and malocclusions often interfere with a child's ability to smoothly and precisely articulate speech sounds. Additionally, children may have poor tongue placement for lingual-based sounds, therefore contributing to the distortion of specific speech sounds. Articulation errors generally involve the distortion of sibilant or rhotic sounds, although other speech sounds may be affected, too. Children with AD frequently substitute developmentally easier consonants /w, s, z/ for later developing consonants /r, θ, ð/; however, they do not demonstrate an impaired phonological system because they understand the difference and meaning of the sounds within a language. Frontal, dentalised, palatal, and lateral lisps are sometimes observed in children with AD (Itagi et al., 2018). Some children are resistant to AD improvements, even with ongoing therapy for years. Speech errors often persist into adulthood as residual articulation errors (McLeod & Baker, 2017).

Incidence and Prevalence

The prevalence of SSD in 4-year-old children is approximately 3.8% (Eadie et al., 2014). Six-year-olds present with comorbid SSD and LI at a rate of 14% (Shriberg et al., 1999), and the occurrence of RD with combined SSD and LI ranges between 1.6% to 8.1% (Pennington & Bishop, 2009). The isolated and comorbid SSD incidence rate suggests that children with SSD likely represent many early school-aged children's speech referrals. Most children diagnosed with SSD exhibit a language-based disorder rather than a motor-based disorder (McLeod & Baker, 2017), and boys are more susceptible than girls to developing SSD (Shriberg et al., 1999). Children with SSD represent the largest percentage of a prekindergarten speech language pathologist's (SLP) caseload (Mullen & Schooling, 2010). Interestingly, 75% of children diagnosed with SSD will completely recover by age 6 (Shriberg, 1994).

There are numerous risk and protective factors associated with childhood SSD, and the presence of risk factors often indicates a child is at a heightened risk of developing SSD. Campbell et al. (2003) conducted a comprehensive study, including 639 children who were 3 years old, to examine potential risk factors associated with a speech delay. The study examined sex, maternal education, socioeconomic status (SES), family history of a speech or language delay, African American race, and persistent otitis media to determine potential contributing factors related to speech delays. Findings revealed that risk factors associated with SSD were male sex, low maternal education, and a history of a developmental communication disorder. Race, SES, and OM were not reported as significant risk factors. McLeod and Baker (2017) identify female sex, sociable temperament, and no family history of speech-language delays as potential protective factors associated with a decreased likelihood of developing SSD. Both risk and protective factors are relevant and should be considered when initiating the assessment process for SSD.

Assessment

The implementation of in-depth and comprehensive communication assessment measures during the SSD evaluation process is paramount. There is empirical data supporting comorbidity between SSD, LI, and RD (Pennington & Bishop, 2009), thus emphasizing the importance of screening all communication domains to prevent further language or literacy delays. The diagnostic process includes preassessment, assessment, and post-assessment tasks, and the time dedicated to each phase varies based on the setting and clinician (Skahan et al., 2007). The preassessment phase involves collecting a case history, parent interview, and completing an observation. A thorough analysis of a child's case history, parent interview, and observation often provides a well-rounded understanding of a child's current communication status and clues the clinician to areas of needed focus. Administration of a hearing and visual screener is essential because impaired hearing or vision may lower assessment scores. An oral mechanism evaluation assesses the integrity of the speech mechanism and oral-motor functioning, which applies to children with AD, as they may have impaired oral structures that need identifying (McLeod & Baker, 2017).

Formal Assessment

The diagnostic process also involves administering formal assessments to determine the status of a child's phonological and articulation abilities. The *Goldman-Fristoe Test of Articulation—Third Edition* (GFTA-3) (Goldman & Fristoe, 2015) is commonly used to assess a child's articulation abilities, and it comprises three sections, including sounds-in-words (SIW), sounds-in-sentences (SIS), and stimulability. Furthermore, consonant production is assessed in the initial, medial, and final position of words. Consonant clusters are also commonly evaluated in the initial position of words. If the clinician suspects a child has a PD, then the *Khan-Lewis Phonological Analysis—Third Edition* (KLPA-3) (Khan & Lewis, 2015) is often administered to supplement the GFTA-3. The KLPA-3 allows for a complete phonological analysis of the child's GFTA-3 responses by examining the developmental phonological and atypical processes. The GFTA-3 and KLPA-3 are both norm-referenced tests; therefore, normative data is used to make comparisons and draw conclusions. Standardized tests are indeed a vital component of the assessment battery, but they should not be the sole determinant of typical-versus-disordered speech (Fabiano-Smith, 2019).

Informal Assessment

Although formal assessments provide quantitative measures that describe a child's phonological and articulation performance, it is essential to elicit speech-language samples (SLS) to gather a complete summation of overall communication status. Indeed, Hoffman and Norris (2002) explain that a higher level of language organization can be examined through naturalistic communication interactions. Clinicians often use naturalistic interactions, such as playtime to elicit SLS from young children. Information regarding a child's expressive and receptive language status is often informally assessed through SLS. Additionally, a child's comprehension and expression of phonology, morphology, semantics, syntax, and pragmatics are also assessed. Phonetic and phonemic inventories are collected from SLS just as voice and fluency are typically informally evaluated in SLS. Children are often administered a literacy screening assessing one or more of the following areas: word reading, phonics, PA, reading comprehension, sentence writing, and story grammar (McLeod & Baker, 2017). Formal assessments need to be administered if language or literacy impairments are suspected based on the SLS. Post-assessment tasks often include calculating intelligibility and severity, analyzing tests, and writing an evaluation report. Level of intelligibility is an especially relevant measure, considering it often indicates if a child is eligible for speech services (Skahan et al., 2007). Clinicians utilize assessment results to develop intervention goals and objectives, as well as to measure a child's progress throughout therapy. Furthermore, it is imperative to assure that all aspects of communication are adequately assessed to warrant a differential diagnosis and determine if a child is at risk of language or literacy delay.

Citation versus Connected Speech Sampling

An analysis of professional literature dedicated to investigating SSD assessment tools reveals that children with SSD often demonstrate differing articulatory performance in citation and connected speech sampling measures. That is, speech sound errors are more prevalent during conversational speech than single-word tasks (DuBois & Bernthal, 1978; Healy & Madison, 1987; Johnson et al., 1980; Klein & Liu-Shea, 2009). An investigation was undertaken by Johnson and colleagues (1980) to analyze the type and quantity of errors elicited during single word and conversational articulation testing. The study comprised 35 children with AD between the ages of 3 to 9 years. The *Goldman Fristoe Test of Articulation* (GFTA) (Goldman & Fristoe, 1972) SIW and SIS subtests were administered, and results revealed that the SIS subtest evidenced significantly more articulatory errors than the SIW subtest. More specifically, phonemes produced accurately during citation sampling were frequently omitted in connected speech. This discovery aligns with Klein and Liu-Shea's (2009) findings, indicating that final consonants elicited during citation sampling were often deleted in conversational speech. Johnson et al. (1980) posited that the discrepancy between the production of phonemes in single word and connected speech tasks might result from increased articulatory planning and time allocations during single word tasks. Moreover, Klein and Liu-Shea (2009) specified that a comprehensive phonological analysis requires the consideration of between-word simplification patterns.

DuBois and Bernthal (1978) conducted a study to compare children’s articulatory competency in three types of sampling tasks, including a continuous speech task, a modeled continuous speech task, and a spontaneous picture naming task. Eighteen participants with AD between 4 to 6 years of age participated in the investigation. Statistical analyses indicated significantly more articulatory errors in the continuous speech task than the other sampling measures, which is consistent with more recent research (Klein & Liu-Shea, 2009). Furthermore, the modeled continuous speech task also evidenced more misarticulations than the single word naming measure. Similar results, were reported by Healy and Madison (1987), upon completing an investigation that analyzed articulatory responses elicited by spontaneous citation and conversational speech sampling methods. The study consisted of 20 children between the ages of 5 to 7 years, and participants were required to demonstrate at least three speech sound errors in conversational speech to meet the eligibility requirements. Data revealed that children produced significantly more misarticulations during spontaneous connected speech. Notably, articulatory errors produced during citation sampling were seldom corrected in conversational speech.

Although multiple investigators have concluded that connected speech samples provide a more comprehensive representation of children's speech repertoire, some studies have noted contradictory evidence. Watson (1989), for example, investigated three sampling measures for eliciting phonological processes in eight children with AD. The study employed citation sampling, imitated sentences, and continuous speech sampling measures. Findings showed that participants' production of phonological processes was relatively consistent across the three sampling methods. Furthermore, a recent investigation was undertaken by Yeh and Liu (2021) to compare single word and connected speech sampling measures in preschool children with SSD. Notably, typically developing peers were included for comparative purposes, and Mandarin was the children's primary language. Results revealed no significant difference between the phonological patterns elicited in the sampling methods, which is in accord with Watson (1989). However, data also indicated that citation samples were better at identifying significant differences regarding speech accuracy, phonemic inventory, and intelligibility between children with SSD and controls. Masterson et al. (2005) also noted that speech accuracy was higher in connected speech than single word samples.

In sum, SLPs utilize various elicitation techniques to obtain samples representative of children's articulatory abilities, especially in connected speech. Peer-reviewed evidence supports that connected speech samples are more informative than single word samples (DuBois & Bernthal, 1978; Healy & Madison, 1987; Johnson et al., 1980; Klein & Liu-Shea, 2009), except for Yeh and Liu (2021). A recent survey of 844 SLPs revealed that approximately 90% of school-based SLPs complete a speech sample during the SSD diagnostic process (Farquharson & Tambyraja, 2019). This statistic suggests that most SLPs consider conversational speech when determining a child's eligibility for services. More research is needed to further specify the advantages and disadvantages between citation and connected speech sampling methods.

Language and Literacy Relationship

Phonological Representations

There is considerable empirical evidence supporting the prevalence of comorbidity among SSD, LI, and RD. An analysis of peer-reviewed evidence is necessary to determine the intricate relationships amongst proclaimed comorbidities. Approximately 21% of 4-year-old children diagnosed with SSD will subsequently develop a comorbid RD (Eadie et al., 2014), and the risk of developing literacy problems increases further when SSD is associated with a concurrent LI (Peterson et al., 2009). An overarching commonality associated with SSD, LI, and RD is difficulty developing phonological representations, which involves storing phonological information about words into long-term memory (Sutherland & Gillon, 2005). Phonological representations are classified as either holistic or segmental. Holistic phonological representations are words stored as single units, whereas segmental phonological representations are words divided into subunits that can be consciously manipulated. Metsala and Ehri (1998) hypothesized that an infant's words are initially stored as whole units; however, words become stored into smaller units as a child's vocabulary develops. Furthermore, as children's phonological representations become segmented, this enables them to complete PA tasks. PA is the ability to detect and manipulate sounds of one's oral language (Anthony et al., 2011) and is often assessed with tasks involving syllables, rhyming, and alliteration. Completing PA tasks requires children to be aware that words consist of smaller units (Rvachew & Grawburg, 2006), thus necessitating the storage of segmental phonological representations.

Multiple Cognitive Deficit Model

Collectively, evidence supports that children with SSD and RD have deficient phonological representations; however, research reveals that all children with SSD do not exhibit a concurrent RD (Bishop and Adams, 1990; Catts, 1993; Nathan et al., 2004), suggesting inadequate phonological representations are not the sole contributing factor to the comorbidity of SSD and RD. The multiple deficit model (Pennington, 2006) attempts to delineate the intricate relationship between SSD and RD by acknowledging that the etiology of developmental disorders extends beyond one specific deficit. Furthermore, the multiple deficit model proposes that "the comorbidity [between SSD and RD] results from a shared cognitive deficit (in phonological representations), which interacts with other non-shared cognitive deficits to produce symptoms that distinguish the two disorders" (Pennington, 2006, p. 399). Children with SSD may or may not exhibit the necessary coexisting cognitive deficits that contribute to literacy difficulties, thus explaining why this population can present with or without a comorbid RD.

Peterson et al. (2009) conducted a longitudinal study to investigate the validity of the multiple cognitive deficit model. The study comprised 123 children between the ages of 7 to 9, and participants were categorized based on confirmation of a childhood SSD diagnosis. Eighty-six children had a history of childhood SSD, and 37 had no speech or LI history. Each participant was evaluated by utilizing predictors of later literacy achievement and other cognitive measures. Specifically, the *Comprehensive Test of Phonological Processing* (CTOPP) (Wagner et al., 1999) elision, blending words, and sound matching tasks were used to assess PA. A rhyming task was also administered, and an auditory conceptualization task replaced the sound matching subtest during the second testing administration. Findings from an earlier study conducted by Raitano et al. (2004), consisting of the same participants between the ages of 5 to 6, were used for comparative purposes. It is noteworthy that Raitano et al.'s (2004) sample comprised four subgroups, including normalized SSD without LI, persistent SSD without LI, normalized SSD with LI, and persistent SSD with LI. Pre-literacy measures were used to assess the four SSD subgroups. An analysis of the findings from both studies revealed that children with a history of SSD might be more inclined to demonstrate reading difficulties relative to typically developing peers.

Additionally, Peterson et al. (2009) found that compared to a model with PA as the only predictor of literacy achievement in the children with SSD, models including PA, syntax, and nonverbal IQ yielded substantially more variance. This discovery aligns with the multiple cognitive deficit model, as it suggests a child's phonological deficit is accompanied by additional cognitive deficiencies, contributing to the development of a concurrent SSD and RD. Interestingly, Peterson et al. (2009) reported a history of concomitant SSD and LI as the strongest predictor of later reading difficulties, signifying a potential link between SSD and LI in determining a child's likelihood of developing RD.

Isolated SSD versus Concomitant LI

The extant literature describing the projected literacy outcomes of children with SSD is somewhat ambiguous. Furthermore, numerous studies indicate that the risk of demonstrating literacy deficits is highly contingent upon whether SSD is concurrent with LI. Lewis et al. (2000), for instance, conducted a longitudinal study to determine if the presence of a comorbid LI contributed to increased reading difficulties in children with an expressive PD. Fifty-two children, ages 4 to 6 years, were identified with a moderate to severe expressive PD. In the third and fourth grades, the children took part in a follow-up study and were categorized based on the presence of a comorbid LI. There were 28 children with an isolated PD and 24 with an expressive PD with LI. Follow-up measures included articulation, phonological processing, language, reading, spelling, and family history data. The PA component of phonological processing was assessed with an elision and a sound analysis task. A sound blending task was included to assess phonemic awareness. Statistical analyses revealed that children with a concurrent LI were at greater risk for future reading challenges than those with an isolated expressive PD. Sices et al.'s (2007) findings for 125 children with moderate-to-severe SSD between 3-6 years of age were in accordance, and results showed that children with comorbid SSD and LI were at heightened risk for pre-literacy deficits.

Moreover, empirical studies indicate concurrent SSD and LI places children at substantial risk for delayed reading acquisition; however, research suggesting children with isolated SSD are subject to potential literacy deficits should not be overlooked. Bird and colleagues (1995) followed a sample of boys during three separate occasions at mean ages of 5.10, 6.7, and 7.7 years. The study comprised three groups, including 18 participants identified with an isolated expressive PD, 13 children with an expressive PD and comorbid LI, and a control group individually matched on age and nonverbal ability. PA was assessed at three time points, whereas literacy skills were only evaluated during the second and third testing administrations. Furthermore, PA was evaluated with tasks, including rime matching, onset matching, and onset segmentation and matching. Literacy measures comprised letter/sound identification, real word reading/spelling, and nonword reading/spelling. Results showed that children with an expressive PD performed more poorly on PA and reading tasks, independent of language status. Similar findings of significantly decreased performance on the same PA measures were found by Rvachew et al. (2003) when investigating the PA skills of children with severely delayed expressive phonological skills but age-appropriate receptive language skills.

An analysis of literature investigating the literacy outcomes of children with isolated SSD versus comorbid SSD and LI reveals that children with isolated SSD are at risk for literacy deficits (Anthony et al., 2011; Bird et al., 1995; Raitano et al., 2004; Rvachew et al., 2003); however, those with concurrent SSD and LI are at even greater risk for academic consequences precipitated by reading deficits (Lewis et al., 2000; Peterson et al., 2009; Raitano et al., 2004; Sices et al., 2007). These findings are certainly of clinical relevance, as they underscore the importance of SLPs being cognizant of the SSD population's predisposition to demonstrating reading deficits. Furthermore, the SSD diagnostic evaluation must encompass all communication domains to identify any potential co-occurring deficits. Implementation of emergent literacy tasks to the SSD treatment regimen, regardless of a child's language status, is crucial to preventing the onset of delayed literacy acquisition.

Phonological Awareness

PA is the ability to analyze the internal sound structure of words auditorily and is concerned with larger units than the individual phoneme. Furthermore, PA is a metalinguistic skill that develops during the preschool and early elementary years and influences other abilities throughout an individual's development (Anthony & Francis, 2005). Tasks involving PA are often placed on a continuum of increasing complexity, including rhyming, sentence segmentation, syllable segmentation and blending, and onset-rime blending and segmentation (Chard & Dickson, 1999). Maturation and development of rudimentary PA skills increase children's awareness of sounds, thus promoting successful completion of PA tasks concerning the individual phoneme. Phonemic awareness, a form of PA, is the ability to manipulate the individual sounds of a language auditorily (Anthony & Francis, 2005). Children must perceive sounds as individual units to complete phonemic awareness tasks such as blending and segmenting the single phonemes that constitute words. Phonemic awareness also encompasses activities such as deleting, adding, substituting, and transposing individual phonemes.

The development of age-appropriate PA abilities is paramount to a child's literacy acquisition, and phonemic awareness is highly indicative of later reading achievement in the early school-age population (Hulme et al., 2002). Furthermore, impoverished phoneme awareness often portends a child will be at risk for delayed reading acquisition. Mounting evidence suggests that children with SSD demonstrate poor PA skills relative to typically developing peers (Anthony et al., 2011; Cowan et al., 1997; Raitano et al., 2004). An analysis of peer-reviewed SSD research is necessary to identify the contributing factors associated with deficient PA abilities and the long-term impact of poor speech sound awareness on reading achievement.

Speech Perception and Receptive Vocabulary

Professional literature is dedicated to investigating the probable predictors of poor PA abilities in the SSD population (Benway et al., 2021; Mortimer & Rvachew, 2008; Rvachew, 2006; Rvachew & Grawburg, 2006), as identification of these predictors will facilitate the implementation of preventive measures to reduce the prevalence of PA deficits. Rvachew and Grawburg (2006) conducted a longitudinal study to identify significant predictors of PA in pre-kindergartners with SSD and to determine if any variables remained predictors at the end of kindergarten. The first segment of the study consisted of 95 prekindergarten children between 4 to 5 years of age. Linear structure equation modeling was used to specify the relationships between the following variables: speech perception, articulation, receptive vocabulary, and emergent literacy. In particular, prekindergarten and kindergarten PA proficiency was evaluated with tasks, including rime awareness, onset awareness, and onset segmentation. Results revealed that speech perception and receptive vocabulary were significant predictors of PA performance, and articulation proficiency did not directly impact PA. Speech perception had a direct effect on PA and an indirect effect that was mediated by receptive vocabulary size. Expectedly, PA was identified as a significant predictor of emergent literacy skills.

The second segment of the investigation was completed at the end of kindergarten, and 47 children between 5-6 years of age took part in the follow-up study. Rvachew's (2006) results indicated that prekindergarten measures of speech perception and receptive vocabulary were associated with PA performance during kindergarten. Benways et al.'s (2021) findings were primarily in agreement for children between 7 to 17 years of age who exhibited residual speech sound errors. Statistical analyses showed that speech perception and receptive vocabulary size were significant predictors of school-age children's PA skills. However, vocabulary was not a significant mediator between perceptual speech acuity and PA. These findings highlight the integral role of speech perception and receptive vocabulary in influencing children's PA abilities, suggesting it may be efficacious to supplement SSD interventions with tasks promoting perceptual speech acuity and vocabulary skills.

Articulatory Proficiency

Rvachew (2006) concluded that articulatory proficiency was not a significant predictor of PA performance in prekindergarten or kindergarten; this finding is surprising considering there is a documented relationship between speech sound abilities and PA. Webster and Plante (1992a), for example, conducted a study to examine the relationship between speech sound abilities and PA. Twenty-two children, ages 6.5 to 8.6 years, participated in the first segment of the study. Eleven children with a moderate to severe PD were individually matched for mental age, with 11 typically developing peers without SSD. The children's PA skills were assessed with the following tasks: sentence-word segmentation and word-syllable segmentation. Pseudoword segmentation and word-phoneme segmentation tasks were used to evaluate phonemic awareness. Statistical analyses revealed that controls performed significantly higher than those with a PD on pseudoword, sentence-word, and word-phoneme segmentation tasks. Webster and Plante (1992b) completed another study to examine variables that may relate to speech sound abilities among young children, including rhyme awareness and alliteration. Thirty children, whose mean age was 3.6 years, took part in the study. Fifteen children with a PD were individually matched for mental age and gender, with 15 typically developing children without SSD. Moreover, findings revealed a moderate correlation between speech intelligibility and PA abilities. The phonologically impaired group performed significantly worse on measures of rhyme awareness, and a significant difference between groups was not observed on alliteration tasks. The type of SSD represented in each sample may have contributed to the disparate findings between Rvachew (2006) and Webster and Plante (1992 a, b).

Although Rvachew (2006) found prekindergarten articulatory accuracy was unrelated to PA performance, a variable explaining variance in kindergarten articulation skills was identified. Prekindergarten speech perception measures explained variance and improvement in kindergarten articulation proficiency for the SSD group. Prekindergarten speech perception abilities affected PA and articulation performance in kindergarten. This discovery underscores a profound treatment implication for SLPs serving young children. Clinicians may consider implementing perceptual speech acuity tasks in SSD treatment plans to simultaneously foster articulatory and PA skills, thus improving speech intelligibility while preventing the potential onset of a comorbid RD.

Speech Error Type

The percentage of consonants correct (PCC) or a standardized articulation score is commonly used to determine a child's articulatory proficiency, especially when investigating the relationship between speech sound abilities and PA performance. Furthermore, accumulating research has elucidated this relationship by examining more specified articulation measures, as children's speech sound errors are dissociable. Articulation errors are categorized as either motorically or linguistically based, and then errors are classified as developmental or non-developmental. Numerous researchers have been interested in investigating the relationship between the type of speech sound error and PA (Brosseau-Lapre & Roepke, 2019; Preston Edwards, 2010; Preston et al. 2013; Leitao et al. 1997; Leitao & Fletcher, 2004), as identification of a specific error pattern associated with deficient PA abilities may facilitate earlier identification of children at risk for delayed reading acquisition.

Preston and Edwards (2010) conducted a longitudinal investigation to examine the relationship between speech sound errors and PA performance. Speech errors were classified as either a distortion, a typical error, or an atypical error, and it was premised that speech errors reflect a child's overall phonological representations. This study examined 43 preschoolers diagnosed with SSD who were 4 to 5 years of age. Assessments were administered to evaluate articulation, receptive vocabulary, and PA. Specifically, PA was assessed with the following tasks: rhyme matching, onset segmentation and matching, onset matching, and blending. Results revealed that distortions and typical errors were not correlated with PA skills, suggesting errors were not indicative of poorly specified phonological representations. However, atypical errors, such as initial consonant deletion and backing, had a significant variance in PA beyond the variance explained by vocabulary and age. Researchers attributed atypical productions to weaker phonological representations.

Preston et al. (2013) completed the second segment of the study approximately 3.5 years after the initial assessments were administered, and 25 children between 5 to 6 years old took part in the follow-up study. The participants' preschool speech error types were used to predict later articulatory abilities, PA, and literacy outcomes. The CTOPP (Wagner et al., 1999) elision and blending subtests were used to evaluate PA abilities. Statistical analyses indicated that atypical preschool speech errors were associated with decreased performance on school-age PA and literacy tasks. Similar findings, were reported by Leitao and Fletcher (2004), upon completing a longitudinal study analyzing the long-term effect of speech error types on PA and literacy skills. Results revealed that atypical error patterns in primary school were correlated with decreased PA, reading accuracy, spelling, and reading comprehension when participants were 12 to 13 years old. These studies suggest that the production of non-developmental speech errors is associated with long-term academic challenges. Moreover, imprecise phonological representations likely contribute to the atypical speech errors, difficulties with phonological processing, and reading issues demonstrated by this subgroup of children with SSD (Leitao & Fletcher, 2004).

A recent investigation was undertaken by Brosseau-Lapre and Roepke (2019) to examine the putative relationship between speech error type and PA. Forty children, ages 4 to 5.9 years old, participated in the study. Twenty participants were identified with SSD, and 20 were classified with typical speech and language abilities. Children with concurrent LI were not excluded from the SSD group. The participants' consonant productions were labeled as either correct, an omission, a substitution, or a distortion error, and the errors were classified as either typical or atypical. The *Comprehensive Test of Phonological Processing- Second Edition* (CTOPP-2; Wagner et al., 2013) elision, blending words, and sound matching skills tasks were used to assess PA skills. Consistent with previous literature, atypical errors were correlated with weakened PA skills; however, a more in-depth analysis revealed that omissions predicted significant variance in PA when receptive language abilities, age, and receptive vocabulary were controlled. Interestingly, Macrae and Tyler (2014) conducted a study of a similar methodology to compare the speech error patterns of children with isolated SSD to those with comorbid SSD and LI. Participants included 28 children, 13 with isolated SSD and 15 with co-occurring SSD and LI, ages 3.6 to 5.5 years old. Results revealed that children with co-occurring SSD and LI produced significantly more omissions and fewer distortions than those with an isolated SSD. Substitution, typical, and atypical errors did not account for significant variance between the two groups. An analysis of studies' findings suggests that atypical speech errors are produced by those with isolated SSD and SSD with concurrent LI; however, the percentage of omissions produced may be a potential distinguishing factor between the two subgroups with SSD (Brosseau-Lapre & Roepke, 2019; Macrae & Tyler 2014).

A literature review suggests that PCC or a standardized articulation score may not adequately predict a child's PA performance (Preston & Edwards, 2010), suggesting a more in-depth error pattern analysis is warranted. Moreover, atypical speech error production is correlated with long-term PA deficits, signifying the importance of completing an error pattern analysis during the SSD diagnostic process. Inadequate phonological representations are a proposed contributor to the speech sound errors and PA difficulties exhibited by some children with SSD. More specifically, atypical errors are associated with weakened or imprecise phonological representations (Preston & Edwards, 2010), whereas omissions result from absent phonological representations (Macrae & Tyler, 2014). Researchers postulate that children with atypical productions are at higher risk of developing RD than children producing typical errors (Foy & Mann, 2011). These findings are indeed pertinent to children demonstrating atypical error productions because weakened PA performance is associated with delayed literacy achievement; therefore, clinicians should consider implementing rudimentary PA tasks to foster literacy and vocabulary development, as well as to prevent the potential development of a comorbid SSD and RD.

Rapid Automatized Naming

Rapid automatized naming tasks (RAN) are commonly administered to assess phonological retrieval, which refers to an individual's ability to recall phonemes associated with specific graphemes (Wagner and Torgersen, 1987). RAN assessments are alphanumeric or non-alphanumeric in nature. Alphanumeric naming tasks comprise symbolic stimuli comprising letters or numbers, whereas non-alphanumeric tasks include non-symbolic stimuli, such as colors and objects. Non-alphanumeric tasks are often used to evaluate pre-readers' phonological access abilities, as mastery of letter and number knowledge is still developing. The successful completion of rapid naming tasks requires children to identify symbolic or non-symbolic stimuli represented in a grid format as rapidly as possible. The research proposes that speeded naming involves accessing phonological representations from long-term memory (Wagner & Torgersen, 1987), and the preciseness of these representations impacts the efficiency of item retrieval (Anthony et al., 2011). Various underlying cognitive mechanisms, including language, attention, visual/perceptual reasoning, and memory retrieval, are identified predictors of RAN performance across children's development (Decker et al., 2013), indicating speeded naming is also influenced by non-phonological cognitive factors. Phonological retrieval is considered a cognitive construct classified as a phonological processing component.

"Phonological processing refers to the use of the sounds of one's language in processing written and oral language" (Wagner & Torgesen, 1987, p. 192) and is divided into three categories, including PA, phonological retrieval, and phonological working memory. Measures of phonological processing are often examined during the diagnostic process, as all components are related and contribute to literacy acquisition. A substantial body of evidence indicates that PA and RAN are interrelated constructs (Bowers 1995; Wagner & Torgersen, 1987). To that end, phonemic awareness is a precursor to literacy acquisition and is most strongly related to reading (Hulme et al., 2002), while phonological retrieval measures predict reading abilities independent from PA (Furnes & Samuelsson, 2011; Manis et al., 2000; Powell & Atkinson, 2021).

The Double-Deficit Hypothesis

Wagner and Torgesen (1987) proposed that PA and phonological retrieval are components of phonological processing, suggesting PA and RAN tasks are highly related and exclusively phonological in nature. Conversely, other investigators contended that different cognitive mechanisms underlie these two constructs, as cumulative studies have demonstrated only a modest correlation between PA and RAN (Cronin, 2013; Georgiou et al., 2008; Kirby et al., 2003; Manis et al., 2000; Wolf & Bowers, 1999). The extant literature has investigated the specific reading-related deficits exhibited by children with dyslexia or a developmental RD (Cronin, 2013; Katzir et al., 2008; Kirby et al., 2003; Wolf et al., 2002), and the analyses reveal that the presentation of dyslexia could be variable. This discovery aligns with Wolf and Bowers' (1999) double-deficit hypothesis (DDH), which postulates that children with dyslexia exhibit a single or double deficit meaning that those with dyslexia could be categorized into three subgroups: a combined PA and RAN deficit, a single PA deficit, or a single RAN deficit. The researchers specified that children with a double deficit diagnosis demonstrate more severe reading dysfunction than those with a single deficit. Wolf and Bowers (1999) also argued that phonological processing is not the sole contributing factor to the completion of RAN tasks, indicating that additional cognitive mechanisms are involved. More specifically, Catts et al. (2002) and Wolf et al. (2000) posited that a timing deficit might contribute to reading challenges beyond phonological processing. An analysis of empirical research is necessary to specify the applicability of the DDH to children with dyslexia and to corroborate the presumed achievement gap among the reading subgroups.

Cronin (2013) conducted a longitudinal investigation to examine the DDH by analyzing children's reading advancement in kindergarten through fifth grade. The study comprised 130 children, including 63 boys and 67 girls; however, only 84 participants remained by fifth grade. Receptive vocabulary was assessed once during the spring semester of preschool; PA and RAN assessments were administered in preschool and kindergarten. Two non-alphanumeric naming tasks were used to assess phonological retrieval; PA was evaluated with a rhyming task, and an end-sound discrimination that task specifically assessed phonemic awareness. However, a single score was used to represent the children's performance on the PA and phonemic awareness tasks. Participants were then divided into four subgroups, including those with no deficit, a combined PA and RAN deficit, a single PA deficit, or a single RAN deficit. Measures of word attack, word reading, and passage comprehension were obtained in preschool through fifth grade. Furthermore, data indicated that RAN and PA offered similar predictive values for word attack and word reading performance throughout elementary school. Wolf and Bowers' (1999) DDH was supported in that three distinct deficit groups were identified, and children with a double deficit demonstrated less reading proficiency than the single deficit subgroups. Notably, the double deficit and single deficit subgroups' preschool and kindergarten PA and RAN scores did not differ statistically. Cronin (2013) postulated that individuals with a single deficit in PA or speeded naming may use compensatory strategies to offset the weakened-skill area, thus explaining why the single deficit groups achieved greater reading outcomes.

Wolf et al. (2002) completed a similar analysis to investigate the DDH and specify PA and RAN's predictive value for word attack, word reading, and passage comprehension measures. The study comprised 144 profoundly impaired second and third-grade readers. It is noteworthy that variables such as SES, IQ, and age were controlled to obviate confounding results. Specifically, an alphanumeric naming task was used to assess phonological access, and PA was evaluated with the blending and elision subtests from the CTOPP (Wagner et al., 1999). The investigators identified four reader subgroups, including those with no deficit, a combined PA and RAN deficit, a single RAN deficit, or a single PA deficit. Participants classified with a double deficit showed decreased performance on all reading measures relative to the other subgroups, which is commensurate with peer-reviewed research (Katzir et al., 2008; Kirby et al., 2003; Lovett et al.,2000). This finding exemplifies that elementary-age children with concomitant RAN and PA deficits are at risk for exhibiting a cascade of reading difficulties. A mild correlation between PA and speeded naming abilities was detected. However, contradictory to Cronin (2013), the present study found PA and RAN to predict unique variance in all literacy measures independently. PA was more predictive of word attack, whereas RAN was more telling of word reading abilities. This discovery suggests that the two constructs are related but affect specific literacy outcomes independently. The relationship between PA and RAN must be investigated further to quantify the strength of the correlation and to delineate the differential predictive values of the two constructs.

Relationship with Phonological Awareness

Researchers have been continuously exploring the association between PA and RAN (Bowers, 1995; Furnes & Samuelsson, 2011; Georgiou et al., 2008; Kirby et al., 2003; Manis et al., 2000; Powell & Atkinson, 2021) to elucidate how each construct uniquely contributes to literacy development. Kirby et al. (2003) conducted a large-scale investigation to examine the correlation between PA and RAN and establish the two constructs' prognostic value concerning elementary-age children's reading achievement. The study comprised 161 kindergarteners, and participants were retested annually until fifth grade. It is noteworthy that a gradual reduction in total sample size was observed throughout the 6-year investigation. PA measures assessed blending onset and rime, blending phonemes, phoneme elision, and sound isolation. RAN assessments evaluated non-symbolic stimuli, including colors and pictures. Statistical analyses revealed a moderate correlation between the two constructs, and kindergarten measures of RAN and PA had differing levels of predictive value depending on the grade level. More specifically, PA was a greater predictor of reading achievement in earlier grades, while RAN was more telling of later grade literacy performance. It was postulated that children in earlier grades, such as kindergarten and first, are more dependent on phonetic decoding; however, older children rely on orthographic knowledge (Kirby et al., 2003), thus potentially explaining why RAN and PA provide differing reading mastery prognoses as children progress through elementary school. Interestingly, additional researchers have reported congruent findings and used a similar rationale to interpret results.

Georgiou et al. (2008) completed an analysis to examine how RAN correlated with measures, including PA, orthographic knowledge, and processing speed. The study followed 62 children from the end of first through third grade. Alphanumeric and non-alphanumeric RAN tasks were used to assess phonological access, and an elision task from the CTOPP (Wagner et al., 1999) was administered to evaluate PA. Data indicated a moderate correlation between RAN and PA in the first grade, yet a weak correlation in the second and third grades. Furthermore, the relationship between RAN and orthographic knowledge increased over time, whereas the correlation between RAN and PA decreased. More evidence regarding the association between PA, RAN, and orthographic knowledge can be drawn from Manis et al.'s (2000) analysis of 85-second graders. Indeed, a mild-to-moderate correlation was established between varying PA and RAN measures, and RAN tasks contributed to unique variance independent from PA. Letter naming speed accounted for twice as much variance in orthographic skill as the two PA measures, agreeing with Bowers and Wolf’s (1993) theory proposing that speeded naming and orthographic processing are highly related constructs. Another salient finding revealed that the poorest readers demonstrated the slowest RAN times, which is well documented in the literature (Bowers 1995; Catts et al., 2002; Wolf 1986).

Bowers (1995) conducted a longitudinal study to investigate the long-term predictive value of RAN, PA, vocabulary, memory span, and coding speed in elementary-age children’s reading achievement. The study followed children from second through fourth grade, and participants were categorized based on overall reading proficiency. Twenty-five participants were identified as poor readers and 21 as average readers. However, the final sample only included 38 participants, as some children could no longer participate in research. The poor reader group was further divided into two groups, including moderately poor readers and poor readers. Specifically, phonological retrieval was assessed with alphanumeric naming tasks. A "which word doesn't belong" task evaluated PA skills, and a phoneme deletion task was used to specifically assess phonemic awareness. Findings revealed that RAN, PA and phonemic awareness, and vocabulary knowledge differentiated the three reader groups. In addition, performance on RAN tasks distinguished fourth-grade students classified as poor readers from the other two reader groups in all grade levels. Similar findings regarding RAN's unique association with poor readers were reported upon McBride-Chang and Manis' (1996) discovery that speeded naming was strongly associated with significantly disabled readers but not good readers. Together, these findings indicate that RAN may be an adequate predictor of profound reading deficits, suggesting it would be advantageous to administer RAN screeners to identify early school-age children at risk of severe reading dysfunction.

A large body of evidence proposes that RAN and PA provide pertinent insight concerning children's specific literacy abilities. For instance, Powell and Atkinson (2021) recently investigated PA and RAN's prognostic value for measures of accuracy and fluency in nonword, exception word, and word reading tasks. The study examined 91 children on three separate occasions at mean ages of 3.83, 5.25, and 6.08 years. Attrition contributed to a decrease in sample size during the investigation, and initial testing occurred prior to the onset of reading acquisition. Non-symbolic RAN tasks were utilized at all time points to evaluate phonological retrieval proficiency; rhyme detection and word completion items were administered to assess PA abilities during initial testing. Various subtests from the CTOPP-2 (Wagner et al., 2013) evaluated PA during the second and third testing administration. An analysis revealed that RAN and PA demonstrated a moderate correlation throughout the investigation. Data indicated PA was associated with nonword reading accuracy but was not predictive of exception word reading accuracy or nonword or word-reading fluency. RAN was associated with exception word reading accuracy but not nonword reading accuracy. However, RAN was predictive of nonword and word-reading fluency. Previous studies have converged on the same conclusion that RAN is more closely associated with reading fluency, whereas PA is more strongly related to nonword reading accuracy (Pennington et al., 2001; Sunseth & Bowers, 2002). To that end, it seems prudent to suggest that PA and RAN share a common phonological processing component (Wagner and Torgerson, 1987); however, additional cognitive mechanisms may contribute to RAN proficiency (Wolf et al., 2000). Taken together, this possibly explains why PA and RAN are individually predictive of various aspects of reading (Powell & Atkinson, 2021).

Relationship with Speech Sound Abilities

Although the extant literature supports a well-established relationship between PA and RAN, research yields mixed findings concerning the correlation between RAN and speech sound abilities. Some investigators have identified an association between RAN and speech sound production (Leitao et al., 1997; Preston, 2008), whereas others have failed to specify a significant link between the two variables (Raitano et al., 2004; Tambyraja et al., 2020). Raitano et al. (2004) conducted a study to determine how the persistence of SSD and a concomitant LI related to children’s emergent literacy skills. The investigation comprised 142 participants between 5 to 6 years of age and comprised five sample groups, including normalized SSD without LI, persistent SSD without LI, normalized SSD with LI, persistent SSD with LI, and typically developing children without SSD or LI. Preliteracy measures encompassed tasks evaluating PA, letter knowledge, and RAN performance. Specifically, non-alphanumeric RAN tasks assessed participants' phonological access abilities. A rhyming task and the elision, blending words, and sound matching tasks from the CTOPP-2 (Wagner et al., 2013) were administered to evaluate PA. Data indicated that speech sound errors and LI status persistence significantly impacted PA performance, even when nonverbal intelligence was covaried. Statistical analyses also revealed that all participants with SSD showed decreased performance on PA and letter knowledge tasks; however, RAN proficiency failed to differentiate children with SSD from controls. Interestingly, additional researchers have reported dissimilar findings concerning RAN's relationship with SSD.

For instance, Leitao et al. (1997) aimed to explore the phonological processing abilities of children with speech and LIs. Eighty children who were approximately 6 years of age took part in the investigation. The participants were divided into four sample groups: isolated SSD, SSD with comorbid LI, isolated LI, and typically developing peers without SSD or LI. Phonological processing proficiency was examined to identify which subgroup of children showed the most profound deficits. PA was evaluated with tasks assessing phoneme segmentation and blending, phoneme elision, and invented spelling. Symbolic and non-symbolic RAN stimuli were utilized to assess phonological retrieval, whereas phonological memory was evaluated with a multisyllabic word repetition task. A significant difference was observed between the isolated SSD and SSD with comorbid LI groups on phonological processing measures. Participants classified with concomitant SSD and LI exhibited more severe phonological processing deficits. However, the isolated SSD and LI groups did not significantly differ in performance. Findings also revealed that speeded naming differentiated controls from the other three sample groups; the control group required less time to complete RAN tasks, which is commensurate with literature examining poor and average readers (Catts et al., 2002; McBride-Chang & Manis, 1996). Notably, non-alphanumeric RAN tasks reached statistical significance; however, alphanumeric naming tasks better distinguished controls from other groups. This finding suggests it may be more efficacious to administer symbolic RAN tasks when assessing children with letter and number knowledge.

Researchers have also been interested in identifying RAN's predictive value concerning the literacy achievement of individuals with SSD, as identification would likely affect the SSD diagnostic process. For example, Sices et al. (2007) explored the relationship between preschool children's emergent literacy skills and reading and writing readiness. One hundred and twenty-five participants, ages 3 to 6 years with moderate-to-severe SSD, participated in the investigation. There were 66 children with concurrent SSD and LI and 59 with an isolated SSD without LI. The study employed various measures of phonological processing, speech, and language to predict reading and writing outcomes. Statistical analyses revealed that grammar and word knowledge indicated children's emergent literacy and writing abilities. Conversely, speeded color naming, articulatory proficiency, and narrative skills were not identified as significant predictors. An additional aim of the investigation was to determine if SSD severity and language status impacted reading and writing readiness. Data indicated that the presence of a comorbid LI influenced reading and writing skills; however, the severity of SSD did not demonstrate a statistically significant effect. This is consistent with Lewis et al.'s (2000) findings concerning children with SSD between 4 and 6 years of age, which revealed that a concurrent LI rather than the severity of SSD influenced reading proficiency.

A recent investigation was undertaken by Tambyraja and colleagues (2020) to examine if children with SSD exhibited a concomitant RD at the beginning of the academic term and, if so, what percentage of those children continued to demonstrate reading difficulties at the end of the school year. The study comprised 120 participants who were in kindergarten through second grade. Notably, 78 children were classified with concurrent SSD and LI, and all participants were enrolled in school-based speech-language therapy services throughout the investigation. RAN, PA, and PCC were individually examined to specify which constructs were related to the initial risk of RD. A pseudoword decoding measure was utilized to establish the participants' RD risk status. Moreover, a nonalphanumeric task was used to evaluate phonological retrieval, and PA was assessed with a deletion task. Statistical analyses indicated that PA and PCC significantly predicted pseudo-word decoding abilities; however, non-symbolic RAN task performance was not a significant predictor. Phonological retrieval was assessed with non-alphanumeric stimuli, which may have adversely affected RAN's predictive value of early literacy and writing outcomes. This postulation is supported by Compton (2003) and Georgiou et al. (2008), who identified alphanumeric RAN tasks as more predictive of literacy achievement than non-alphanumeric tasks. Tambyraja et al.'s (2020) most interesting finding revealed that approximately 1/3 of participants demonstrated RD risk at the start of the school year, and 2/3 remained at risk for RD by the end of the academic term. This discovery underscores the prevalence of concomitant RD risk among the SSD population. This finding yields significant implications regarding clinicians' initial assessment procedures and treatment plans. Children's written language abilities should be considered during SSD evaluations, and it may be beneficial to incorporate literacy concepts into SSD treatments to preclude the onset of reading breakdown.

Phonological retrieval proficiency, often assessed via symbolic or non-symbolic RAN tasks, has been identified by some investigators as an adequate predictor of the SSD population's literacy outcomes. For instance, Anthony et al. (2011) completed an analysis to better understand the relationship between phonological processing and SSD by examining 204 participants: 68 children with SSD, 68 language-matched peers without SSD, and 68 typically developing peers. Elision and blending tasks from the *Preschool Comprehensive Test of Phonological and Print Processing* (PCTOPPP) (Lonigan et al., 2002) were used to assess PA, and RAN was evaluated with non-alphanumeric stimuli. Expressive phonology, oral language, print awareness, the distinctiveness of phonological representations, and reading were also examined. Results showed that preschool-age children with SSD performed worse than typically developing children on all PA tasks. Weakened phonological representations explain decreased PA proficiency, and decreased vocabulary knowledge may directly contribute to imprecise phonological representations. Vocabulary has proven to be the most reliable language measure when predicting PA (Preston & Edwards, 2010), and vocabulary development is thought to contribute to the development of more precise phonological representations. Data revealed that children with SSD demonstrated slower phonological access to highly familiar words than typically developing peers on RAN tasks. Weaknesses in accessing phonological representations and generalized motor slowing are plausible explanations for lower RAN scores. Lewis et al.'s (2011) findings in children with SSD between 4 and 6 years of age were in accordance with this interpretation, which indicates that difficulties with RAN may be associated with both early SSD, LI, and later spoken language skills.

Interestingly, Pennington and Bishop (2009) suggest a relationship between rapid naming and the comorbidity of SSD, LI, and RD. The presence or absence of rapid naming deficits in

SSD and LI may relate to their comorbidity with later RD. There is a surprising shortage of investigations dedicated to specifically examining the long-term effects of weakened RAN performance in early school-aged children with SSD. Considering the comorbidity of SSD and RD (Pennington & Bishop, 2009, Tambyraja et al., 2020), and that children with SSD often present with delayed reading acquisition (Anthony et al., 2011), it seems prudent to also evaluate phonological retrieval abilities when assessing children for SSD. Likewise, if children with SSD present with a concomitant literacy delay, then literacy supports can be included in the SSD treatment plan to prevent the adverse effects of delayed reading acquisition.

Motoric Relationship

Empirical research proposes the comorbidity of LI and RD in children with SSD; however, literature also suggests evidence of a relationship between motoric deficits and speech and LIs (Rechetnikov & Maitra, 2009). Approximately 40% to 90% of children diagnosed with a speech or LI often demonstrate clinical indicators of a motoric impairment (Hill, 2001). Furthermore, underlying neurological mechanisms are believed to play a pivotal role in explaining why childhood speech and LIs often coincide with subpar motoric abilities. Some children with SSD present with deficits in motor planning and programming that adversely affect their motor speech production. Interestingly, researchers postulate a connection between the planning and programming mechanisms associated with speech production and fine motor skills (Dewey, 1993). A first glance at children's oral-motor abilities often occurs during a diadochokinetic rate (DDK) assessment, and if the results are poor, then potential concomitant non-speech-related motoric deficits should be considered.

Diadochokinesis

Clinicians often administer DDK tasks to assess motor speech sequencing and production rate, as academic literature suggests that children with SSD can present with oral-motor difficulties (Bernthal et al., 2017). Verbal DDK refers to "the production of rapidly alternating syllables" (Fletcher, 1972, p. 763) and typically involves rapid repetition of /pʌ tʌ kʌ/, whereas nonverbal DDK is frequently evaluated with lingual protrusion and lateralization tasks. DDK proficiency is measured in terms of accuracy, rate, and consistency of production (Williams & Stackhouse, 1998). Multiple studies investigating DDK performance in children with SSD versus typically developing peers have been conducted and discovered that the SSD population demonstrates decreased performance on rapid syllable repetition tasks (Dworkin, 1978; McNutt, 1977; Williams & Stackhouse, 1998; Tuomi & Winter, 1997). However, it is noteworthy that nonsignificant DDK findings between children with SSD and typically developing peers have also been reported (Lewis et al., 2011; Prins, 1962).

McNutt (1977) and Dworkin (1978) employed investigations to explore the relationship between specific types of speech errors and DDK proficiency. McNutt (1977) examined 45 children between the ages of 13 to 14, and participants were categorized based on the articulation error type. The study consisted of three groups, including 15 children with only /r/ misarticulations, 15 participants with only /s/ misarticulations, and a control group with no articulatory errors. The participants' oral sensory and oral motor abilities were examined to specify their association with each type of articulation error. More specifically, oral sensory abilities were assessed with two-point discrimination and oral-form discrimination tasks, and oral motor abilities were evaluated with alternating motor rate (AMR) tasks. Statistical analyses revealed that /r/ misarticulations were associated with deficient oral sensory and oral motor performance, whereas /s/ misarticulations were related only to oral motor deficits. These findings indicate that children with /r/ and /s/ misarticulations demonstrated poorer performance on DDK measures than controls. Along the same lines, Dworkin (1978) subsequently reported that speech error type was related to DDK performance upon completing an investigation that examined the relationship between lingual strength and articulatory abilities of children with and without a frontal lisp. The study comprised 45 children that exhibited a frontal lisp (/s/ and /z/) and 45 controls with normal articulation. Measures of DDK and protrusive lingual force were obtained. Data indicated that DDK and protrusive lingual force proficiency were significantly reduced in participants with a frontal lisp, suggesting reduced lingual force is related to lingual incoordination and bradykinesia (Dworkin,1978). Taken together, McNutt's (1977) and Dworkin's (1978) findings support that speech errors, such as misarticulations of /s/ or /r/ and frontal lisps, are related to children's performance on rapid syllable repetition tasks.

Tuomi and Winter (1997) conducted a study to investigate the correlation between the degree of articulation impairment and DDK proficiency. The participants were divided into two groups, comprising nine 6-year-old children and nine 8-year-old children. A standardized articulation test, an oral apraxia test, and a DDK task was administered to the participants. Results showed that a more severe articulation impairment contributed to heightened difficulty on DDK tasks; thus, children with decreased articulatory proficiency demonstrated slower DDK rates. In particular, the 8-year-old children demonstrated faster DDK rates than the 6-year-old children, which suggests motor coordination improves as maturation occurs, even in children with an articulation impairment. Furthermore, SSDs are associated with oral-motor coordination difficulties related to speech production, and it is plausible to suggest motoric deficits may extend beyond the realm of speech production tasks. Disparate findings were reported by Lewis et al. (2011) upon completing a large-scale investigation examining the association between SSD and five endophenotypes. Data showed that RAN and oral motor skills were not related to SSD severity. In sum, empirical studies dedicated to investigating the relationship between oral motor abilities and SSD are relatively scarce; thus, additional research is required to specify the relationship between these two constructs.

Gestures

Infants' motoric capacity flourishes during the first 18 months of life, which transforms their interactions with objects and people (Iverson, 2010). This development fosters early communication and language development. An early motorically-based communicative act is gesture usage, which typically emerges between 7 months and 1 year (Iverson, 2010). Interestingly, a recent investigation was undertaken by Alcock and Connor (2021) to examine the long-term relationships between the motoric and linguistic abilities of young children. Measures of language comprehension and production, oral motor skills, meaningless manual gestures, and fine and gross motor skills were obtained at 3 and 4 years of age. It is noteworthy that gesture tasks were not related to language, and motor tasks were not symbolic in nature. Data from an earlier study (Alcock & Krawczyk, 2010) which comprised some of the same participants at 21 months of age were used for comparative purposes. Statistical analyses revealed that oral motor skills were uniquely related to language production abilities at 21 months and remained associated at 3 years.

Likewise, Nip et al. (2011) reported that developmental changes in orofacial movement speed were associated with developmental advancement of linguistic and cognitive abilities while periodically examining 24 children between the ages of 9 and 21 months. Alcock and Krawczyk (2010) also discovered that meaningless gestures and fine and gross motor skills were associated with language comprehension at 3 years of age. O'Reilly et al.'s (1997) findings from two separate studies revealed that early symbolic gestures were associated with receptive language abilities. Symbolic gesture comprehension was correlated with language comprehension at 24 and 36 months and 4 and 5 years. Alcock and Connor's (2021) investigation differed from the previously mentioned studies in that only non-symbolic gestures were examined. Thus, it was hypothesized that the association between non-symbolic gestures and language was of clinical relevance, as it signified that a common underlying neurological mechanism likely underlies early linguistic and motoric abilities.

Isolated Speech Impairment

To date, only a few studies have examined the correlation between isolated speech impairments and motoric deficits, as most investigations comprised samples with isolated LI or concurrent SSD and LI (Finlay & McPhillips, 2013; Owen & McKinlay, 1997; Webster et al., 2005). However, investigators have reported clinically relevant findings concerning the motor profile of children diagnosed with an isolated speech impairment. Visscher and colleagues (2007), for example, completed an investigation to gain a better understanding of how speech and LIs related to motoric performance by examining 125 participants: 46 children with LI, 14 children with an isolated speech impairment, and 65 children with a comorbid speech and LI. All participants were between 6 and 9 years of age, and Dutch was their primary language. Motoric measures included manual dexterity, ball skills, and static and dynamic balance. Statistical analyses revealed that children with speech and/or LI demonstrated impaired motoric abilities. Notably, the participants with an isolated speech disorder performed worse on motor measures than those with LI. This finding is consistent with Visscher et al.'s (2010) discovery that children with speech and/or LIs scored lower on gross motor assessments, with the LI group obtaining higher motor scores than those with an isolated speech impairment or a comorbid speech and LI. Visscher et al.'s (2007) and (2010) findings must be interpreted with caution, as English was not the participants' primary language, and a small sample represented isolated speech impairment.

More evidence regarding the association between specific speech impairments and motoric deficits can be drawn from Carroll et al.'s (1989) and Jenkins and Lohr's (1964) investigations of children with ADs. Carroll and colleagues (1989) conducted a study to compare the visual-motor skills of children with and without an AD, and results revealed that an AD was associated with deficient performance on visual-motor tasks. Similarly, Jenkins and Lohr (1964) explored the motoric skills of 76 first graders and discovered that participants with an AD performed worse than controls on motor measures. Interestingly, Bishop (2002) postulates that there may be a genetic link between speech and motoric abilities, thus potentially explaining why some children with SSD exhibit subpar motoric abilities. To investigate the comorbidity of speech and motoric impairments, Bishop (2002) analyzed the finger tapping rate of 22 dizygotic and 57 monozygotic twins with a speech and/or LI. A control group of 173 single-born children was included to provide normative data for the motoric task. Results showed that participants with a speech and/or LI demonstrated a significantly slower finger tapping rate relative to controls. In addition, data suggested a genetic association between communication and motoric disorders, with the link being greater for speech rather than LIs. The literature reviewed in this section certainly supports the concomitance of speech and motoric impairments. Research proposes that children's motoric proficiency is significantly associated with cognitive development (Piek et al., 2008; Son & Meisels, 2006), thus further underscoring the importance of considering non-speech-based motoric abilities during the SSD evaluation process.

Handwriting

Considerable evidence supports that children's early motoric abilities are predictive of later academic achievement (Dinehart & Manfra, 2013; Grissmer et al., 2010; Son and Meisels, 2006), which is clinically relevant to the SSD population as motor immaturity has been linked to speech impairments (Bishop, 2002; Carroll et al., 1989; Visscher et al., 2010). In particular, handwriting competency has received substantial attention due to its fundamental role in children's academic attainment (Dinehart, 2014). Many individuals argue that technological advancements within schools, such as the increased prevalence of portable computers, may make handwriting skills less essential or even obsolete. However, a recent investigation by Fogo and colleagues (2020) found that kindergarteners spent approximately 30% of their school day occupied with fine motor tasks, of which 30.75% of the time was spent completing handwriting-related activities. This statistic underlines how significant handwriting proficiency is to the early-school age population, even in the twenty-first century. A literature analysis is necessary to determine the specific academic areas that handwriting affects.

Furthermore, Dinehart and Manfra (2013) aimed to explore the relationship between preschoolers' fine motor skills and subsequent academic achievement in second grade. The study comprised 3,903 economically disadvantaged students, and preschool achievement data was used to predict the level of academic growth in second grade. Fine motor abilities were divided into two categories, including object manipulation and fine motor writing. Results revealed that preschoolers' object manipulation and fine motor writing skills significantly predicted second-grade academic attainment. Notably, early fine motor writing proficiency was more predictive of second graders' math and reading performance than object manipulation skills.

Son and Meisels (2006) conducted a similar investigation and reported an association between fine motor abilities and academic success. Furthermore, the study analyzed 12,583 children to specify the relationship between early motoric abilities and academic success in the first grade. The kindergarteners' motoric skills served as potential predictors of reading and math proficiency in the first grade. Motor measures comprised tasks evaluating the kindergarteners' fine and gross motor abilities. Statistical analyses revealed that early gross and fine motor skills were indicative of later academic attainment. However, fine motor skills, specifically visual-motor abilities, were more predictive of first grade reading and math achievement. This discovery is notable, as handwriting is a type of visual-motor skill (Dinehart, 2014), and there is a documented correlation between visual-motor abilities and handwriting competency (Daly et al., 2003; Marr et al., 2001). This is relevant to the SSD population, as studies have identified impaired visuomotor skills in children with ADs (Carroll et al., 1989; Ercan et al., 2016).

A growing body of literature suggests that children with speech and/or LIs demonstrate written expression deficits in the areas of quality and organization of writing (Kim et al., 2015), lexical diversity and spelling (Puranik et al., 2006), and grammar (Windsor et al., 2000). Interestingly, researchers have identified a significant link between children's handwriting proficiency and written expression. Puranik and Altoabia (2011) investigated the influence of handwriting and spelling on the written expression abilities of 242 kindergarteners. The study employed measures of written expression, spelling, handwriting fluency, oral language, cognition, PA, and reading. Specifically, the handwriting task required participants to write the alphabet letters in order, using lower case letters. A moderate to strong correlation between spelling and handwriting fluency was detected, commensurate with literature examining the school-age population (Pontart et al., 2013). Statistical analyses also revealed that handwriting demonstrated a moderate to weak correlation with verbal and nonverbal IQ, reading, and oral language. Notably, spelling and handwriting contributed to children's written expression proficiency; however, handwriting fluency accounted for the most unique variance.

While no studies have directly investigated the relationship between written language and handwriting proficiency in children with SSD, there are some investigations dedicated to examining the handwriting of those with speech and/or LIs. Connelly and colleagues (2012), for example, assessed children with and without a specific LI to determine what variables may impact the quality of composition and written language bursts. Ninety-nine children who were 11 years of age took part in the investigation. The participants were divided into three sample groups: 33 children with SLI, 33 peers matched for age and gender, and 33 children matched for gender and language abilities. Measures of handwriting fluency, nonverbal ability, spelling, and working memory were obtained. Results showed a high-moderate correlation between handwriting fluency and spelling, consistent with Puranik and Altoabia's (2011) data. Further investigation of the data revealed that spelling and handwriting automaticity were significant predictors of burst length and text quality for all sample groups. Similar findings, regarding handwriting's unique association with written text, were reported upon Jones and Christensen's (1999) discovery that handwriting automaticity accounted for 67% variance in written expression.

Taken together, the evidence reviewed here suggests that handwriting proficiency plays a pivotal role in children's academic success, particularly in the areas of math, reading, and written expression. Given that some children with SSD exhibit fine motor deficits (Newmeyer et al., 2007) and that handwriting competency is related to the written expression of those with LI (Connelly et al., 2012), it seems logical to suggest that handwriting may also impact the SSD population. Although, additional research is needed to specify the relationship between handwriting and speech sound abilities. Research has shown that proficient handwriting may facilitate early reading acquisition (James & Engelhardt, 2012), thus emphasizing the importance of emergent readers engaging in pencil and paper tasks. Furthermore, SLPs working with the early-school-age population may consider implementing letter-writing tasks into therapy plans to supplement children's emergent writing skills (Puranik et al., 2018) and fine motor abilities.

Broca's Area

Studies suggest that childhood speech and LIs often coincide with impaired non-speech-based motoric functioning. Moreover, Newmeyer et al. (2007) investigated the association between SSD and fine motor skills, specifically, to formulate a potential explanation for this comorbid relationship. The study consisted of 32 children diagnosed with severe SSD, and the following areas were assessed: oral movement, auditory comprehension, expressive communication, grasping, object manipulation, and visual-motor integration. Findings revealed that children with SSD demonstrated below-average fine motor functioning compared to age-matched peers. In particular, there was an association between oral-motor imitation and visual-motor integration. A potential rationalization for this correlation is an underlying neurological structure involved in facilitating both the production of speech and fine motor tasks. An experiment conducted by Heiser et al. (2003) utilizing repetitive transcranial magnetic stimulation (rTMS) revealed that Broca's area is indeed involved in tasks beyond the realm of speech and language. Furthermore, data suggested that Broca's area is essential for imitation of finger tapping, which is a fine motor task. Extensive research indicates that Broca's area houses mirror neurons that fire when a motor action is observed and executed (Ferrari et al., 2003), therefore, signifying a relationship between perception and production of motor actions.

Inadequate mirror neuron performance in Broca's area is certainly a plausible explanation for why children with speech and language delays often demonstrate difficulties with visuomotor tasks, such as threading beads and tapping, which require strong eye-hand coordination (Visscher et al., 2007). Moreover, abnormalities in Broca's area may cause inadequate planning and processing, thus contributing to poor execution of both speech and fine motor tasks.

Cerebellar Influence

Redle et al. (2015) conducted a functional MRI on 12 children with persistent SSD to further explore the neural relationships associated with oral-motor and fine motor execution. Statistical analyses revealed that children with SSD performed significantly lower than controls on fine motor and oral-motor tasks that were challenging and timed. Interestingly, MRI results displayed increased activation in the cerebellum during oral-motor and fine motor execution. Tkach et al. (2011) also noted hyperactivation in the cerebellum when six children with SSD performed speech production tasks. These findings suggest cerebellar differences are another potential contributing factor to the comorbidity of SSD and motoric impairments. Indeed, the cerebellum is integral for executing fine motor tasks, maintaining balance, and monitoring timing mechanisms (Manto et al., 2011).

Furthermore, investigations examining children with speech or LIs frequently note below-average performance on challenging and timed motor tasks. Wolff et al. (1990) reported poor results when examining bimanual coordination tasks requiring timely precision in children with dyslexia. Brookman et al.'s (2013) findings were in accordance and revealed that children with LI only demonstrated significant deficits when fine motor tasks were speeded and intricate. It is reasonable to postulate that children with SSD are often impoverished of the neurological resources required to execute particular speech and fine motor movements; therefore, this population hyperactivates the cerebellum to meet the motoric demands of especially challenging and speedy tasks (Redle et al., 2015). Indeed, peer-reviewed literature supports that speech and LIs are often associated with comorbid motoric impairments (Hill, 2001; Rechetnikov & Maitra, 2009), which is relevant and supports the need to administer more comprehensive developmental assessments when evaluating children for SSD. An occupational or physical therapy referral may be warranted if developmental assessments indicate that a child demonstrates below-average motoric functioning.

Purpose

The purpose of the present study was to investigate the complex relationships that may relate to speech sound abilities, including PA, RAN, and non-speech-based motoric abilities, among the early school-age population. The variables were examined to determine if there were any significant correlations between them, thus identifying factors associated with speech sound abilities. The primary investigator hypothesized that speech sound proficiency is associated with PA, RAN, and non-speech-based motoric abilities in early school-age children. Much research suggests comorbidity of LI and RD in children with SSD (Pennington & Bishop, 2009). This study aimed to further support the relationship between speech sound abilities and language/literacy achievement with the intent of possibly recommending an implementation of adjunct therapies to prevent the manifestation of language and literacy delays into other aspects of development. Peer-reviewed literature also supports the comorbidity of motoric deficits in children with speech and LIs (Rechetnikov & Maitra, 2009), but specifically, the cumulative research exploring this comorbidity is still lacking. This investigation further examined the association between non-speech-based motoric and speech sound abilities. Comprehensive developmental testing in motor areas and occupational/physical therapy referrals may be warranted if a significant relationship is identified.

Experimental Question

1. Will speech sound proficiency be associated with PA, RAN, and non-speech-based motoric abilities in early school-age children?

Chapter III

Methods

Participants

This study was approved by the Valdosta State University Institutional Review Board prior to the recruitment of participants (see Appendix A). The sample for the study comprised 70 participants, including 34 males and 36 females. The age of participants ranged from 4.0 years to 7.92 years (mean age=5.90 years). All participants were native English speakers. Children varied in the levels of speech sound, motoric, and reading abilities, and no requirement was necessary for testing other than age. Flyers were posted around and given to parents at Valdosta State University's Speech and Hearing Clinic, Valdosta State University's Sullivan Literacy Center, Coastal Plain Head Start, and The Boys and Girls Club in Valdosta, Georgia (see Appendix B).

No participants were rejected from the study. The only criteria for participation in the research was being at least 4 years of age and not older than 7 years. Children diagnosed with an inconsistent phonological disorder, CAS, and childhood dysarthria were not recruited for this study. The entire original sample size of 70 participants was included in the analysis of results.

Procedures

Parents of the potential participants were given a parental permission form to complete prior to each child's evaluation (see Appendix C). In addition, each child was read aloud a verbal assent form by the primary researcher (see Appendix D). The evaluations only occurred once a "yes" response from each child was obtained. Following each evaluation, each child received a complimentary monetary amount of $10, and parents received a brief evaluation summary, which explained how their child performed on the assessments administered during the evaluation. Parents were encouraged to contact the researchers if they had comments, concerns, or questions regarding the information included within each summary. The data collection sessions were completed on-site at the Valdosta State University Speech and Hearing Clinic, Coastal Plain Head Start, and The Boys and Girls Club in Valdosta, Georgia.

Formal measures were used to assess the participants' abilities, including speech sound production, phonological processing, and non-speech-based motoric proficiency (see Appendix E). Administration of test order was counterbalanced to reduce the likelihood of fatigue systematically affecting the results. The following subtests were administered: CTOPP-2 (Wagner et al., 2013) PA and RAN subtests, GFTA-3 (Goldman & Fristoe, 2015) SIW and SIS subtests, and *Bruininks-Oseretsky Test of Motor Proficiency-Second Edition* (BOT-2) (Bruininks & Bruininks, 2005) short test. Administration of the previously mentioned subtests allowed for examination of the complex relationships that may relate to speech sound abilities, including PA, RAN, and non-speech-based motoric abilities, among the early school-age population.

The CTOPP-2 (Wagner et al., 2013) subtests of Elision, Blending Words, and Sound Matching or Phoneme Insolation were administered to assess the participants' PA abilities. The Elision subtest measured the extent to which a participant could say a word and then say what was left after omitting certain sounds. In this subtest, the child was asked to repeat a word such as *toothbrush* and then say toothbrush without saying *tooth.* This subtest comprised 34 items, and examiner feedback was provided on items 1-12. The Blending Words subtest measured a participant's ability to combine sounds to form a word. For this subtest, the child listened to a recording of words presented in small parts and then combined these parts to make a word. For example, listen to the sounds *skate-board* then put them together to make the word *skateboard.* This subtest comprised 33 items, and examiner feedback was provided on items 1-12. The third PA subtest comprised two versions, including a separate form for participants ages 4-6 and 7.

Children between the ages of 4 and 6 were administered the Sound Matching subtest. This subtest measured the extent to which a participant could match sounds, and a picture book was used for both portions of the subtest. In part one of the subtest, the child was shown a series of three pictures, and the name of each picture was read aloud by the examiner. The child was then asked to point to the picture with a specific sound, such as the */n/* sound in the *neck*. The second portion of the subtest used the same method, except the participant was asked to point to the picture that ended with a specific sound such as the */m/* sound in *gum*. This subtest comprised 26 items, and examiner feedback was provided on items 1-6 and 14-19. The Phoneme Isolation subtest was administered to participants that were 7 years old, and it measured the extent to which a participant could identify specific sounds in words. For this subtest, the child was asked to play a word game requiring him or her to say parts of words. For example, what is the *first* sound in *fan* and the *last* sound in *mop*? This subtest comprised 32 items, and examiner feedback was provided on items 1-7 and 17-23. Test items increased in complexity as each subtest progressed, and testing was discontinued after a ceiling of three consecutive incorrect responses was obtained for each PA subtest.

The CTOPP-2 (Wagner et al., 2013) RAN subtests were administered to evaluate the participants' phonological access abilities. The Rapid Digit Naming and Rapid Letter Naming subtests were administered to assess a child's rapid symbolic naming abilities. The Rapid Symbolic Naming subtests measured the speed at which a participant could name numbers and letters. The Rapid Color Naming and Rapid Object Naming subtests were administered if a participant failed to show adequate knowledge of letters and numbers. The Rapid Non-Symbolic Naming subtests measured the speed at which a participant could name colors and objects. A blank piece of paper was used to cover each RAN subtest prior to testing, and the paper was removed once the stopwatch started. Children were asked to identify 32 symbolic or non-symbolic stimuli as rapidly as possible, represented in a grid format. There was no specified time limit for the RAN subtests; however, the length of time needed to complete each naming task was recorded on the test form. Incorrect responses were also noted.

The GFTA-3 (Goldman & Fristoe, 2015) SIW and SIS subtests were administered to assess the participants' speech sound abilities. The GFTA-3 (Goldman & Fristoe, 2015). provided many opportunities to elicit the production of 23 consonant and 16 consonant cluster sounds in different word positions. The SIW subtest used a picture-naming task to elicit the production of 60 single words, including 23 consonant sounds in the initial position, 1 in the medial position, and 1 in the final position of words (Goldman & Fristoe, 2015). For this subtest, the examiner pointed to a picture such as a *truck*, and the participant was asked to name the object. A verbal prompt was provided if a child could not name a particular stimulus item. The SIS subtest comprised two versions, including a separate form for participants ages 4-6 and 7. Both versions of the SIS subtest used a sentence retell task in a story format to elicit speech sounds in connected speech. Children between the ages of 4-6 were read a story titled "What Animal Do You Think It Is?" This story contained 43 target words to elicit the production of 21 consonants and nine consonant clusters in the initial, medial, and final position of words (Goldman & Fristoe, 2015). Participants that were 7 years old were read a story titled "A Terrible Day." This story contained 31 target words to elicit the production of 19 consonants and nine consonant clusters in the initial, medial, and final position of words (Goldman & Fristoe, 2015). For both versions of the SIS subtests, the examiner read a sentence such as *a fly is buzzing around her cheese sandwich,* and the child was asked to repeat the sentence. The sentence was repeated if the child could not recall or repeat the entire sentence. The participants' productions for the SIW and SIS subtests were not phonetically transcribed by the examiner, as only composite scores were considered in the analysis of the results.

The BOT-2 (Bruininks & Bruininks, 2005) short form was administered to assess the participants' non-speech-based motoric abilities. The BOT-2 short form comprised eight subtests that evaluated the following areas: fine motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, running speed and agility, upper-limb coordination, and strength. Each subtest comprised one or two simple tasks to summarize a participant's overall motor proficiency, and the examiner provided a demonstration prior to asking the participant to complete a task independently. Fine motor precision was assessed through a maze drawing and folding paper activity. Fine motor integration was evaluated by asking a participant to redraw a star and square illustrated in the stimulus book. A penny transferring activity was used to assess manual dexterity. Bilateral coordination was evaluated by jumping in place (same sides synchronized) and then tapping feet and fingers (same sides synchronized). Balance was assessed by asking participants to walk forward on a line and then stand on one leg on a balance beam with their eyes open. A one-legged stationary hopping activity was used to assess running speed and agility. Upper-limb coordination was evaluated by asking participants to catch and drop the ball with both hands and dribble the ball with alternating hands. Strength was assessed through sit-up and push-up tasks, and participants could perform knee or full push-ups. If a participant could not complete a specific motor activity, the examiner moved on to the next task listed in the record form.

Measures

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

The CTOPP-2 (Wagner et al., 2013) was utilized to assess phonological processing skills related to reading, including PA and RAN. Data was collected as scaled scores (average range= 8-12) computed from the raw scores obtained from the administration of each subtest. The PA composite score (average 90-110) for children ages 4-6, was derived from the Elision, Blending Words, and Sound Matching scaled scores. The PA composite score (average=90-110) for children aged 7, was derived from the Elision, Blending Words, and Phoneme Isolation scaled scores. The Rapid Symbolic Naming composite score (90-110) was derived from the Rapid Digit Naming and Rapid Letter Naming scaled scores. The Rapid Non-Symbolic Naming composite score (90-110) was derived from the Rapid Color Naming and Rapid Object Naming scaled scores.

Goldman-Fristoe Test of Articulation-Third Edition (GFTA-3)

The GFTA-3 (Goldman and Fristoe, 2015) assessed articulatory proficiency in single words and connected speech. Data was collected as composite scores (average range= 86-114), computed from the raw scores obtained from the administration of each subtest. An individual composite score was obtained for the SIW and SIS subtests.

Bruininks-Oseretsky Test of Motor Proficiency-Second Edition (BOT-2)

The BOT-2 (Bruininks & Bruininks, 2005) short form was utilized to assess non-speech-based motoric abilities. Data was collected as a composite score (average range= 41-59) computed from the overall raw score obtained from the administration of each subtest within the BOT-2 short form.

Data from all testing administrations was collected in real-time on the corresponding record forms for each test. The participants completed the components from all three tests independently in one sitting, with breaks provided as necessary. The primary researcher completed the scoring of each test after the administration of testing took place.

Analysis

Once the standardized scores were obtained from the GFTA-2, CTOPP-2 PA, CTOPP-2 RAN, BOT-2, the scores were subjected to Pearson product-moment correlations analyses. In addition, each of these standardized scores served as the dependent variable, or target, in a series of predictive regression analyses. The predictive capability of the other scores was investigated utilizing a series of stepwise multiple regression analyses. The first analysis used a stepwise linear regression model on the *GFTA-3 SIS* standard scores with the *GFTA-3 SIW, CTOPP-2 RAN, CTOPP-2 PA, and BOT-2* scores entered into the model as potential predictors. The *GFTA-3 SIW* scores were removed in a subsequent analysis since the subtests are both from the same assessment tool and are typically administered in tandem. All variables were entered into the stepwise analyses for all other target data (CTOPP-2 RAN, CTOPP-2 PA, and BOT-2).

Chapter IV

Results

To examine the relationships between the non-speech-based motoric, PA, RAN, and speech sound abilities of early school-aged children, the previously mentioned standardized assessments were administered to the 70 participants. The mean standard scores, percentile ranks, and standard deviations for each of the subtests are provided in Table 1.

Table 1. *Descriptive Statistics: Mean Standard Scores*

Subtest	Mean Score (SD)	Mean Percentile Rank (SD)
CTOPP-2 PA^{+}	88.67 (14.05)	29.84 (24.49)
CTOPP-2 RAN^{+}	87.71 (19.19)	38.93 (24.66)
GFTA-3 SIW^{-}	95.87 (15.83)	44.39 (28.21)
GFTA-3 SIS^{-}	102.79 (13.35)	57.07 (27.46)
BOT-2*	48.06 (7.60)	43.90 (24.89)

Note. + denotes standard score, average= 100, standard deviation= 10
- denotes standard score, average= 100, standard deviation= 15
* denotes standard score, average= 50, standard deviation= 10

Regression Analyses

In the first statistical stepwise analysis, all subtest scores from all assessment tools were utilized as potential predictors of the *GFTA-3 SIS* scores. When assessing which subtest best predicted the *GFTA-3 SIS* scores, the stepwise analysis indicated that *GFTA-3 SIW* was the sole significant predictor, $F(1{,}68) = 335.76$, $p < .00$, $R^2 = .83$, $R^2_{Adjusted} = .83$. The results suggest that 83% of the variance in the *GFTA-3 SIS* scores can be accounted for by administering the *GFTA-3 SIW* subtest.

When all *GFTA-3* variables were removed from the analysis as potential predictors of *GFTA-3 SIS* scores, scores from the *BOT-2* and the *CTOPP-2 PA* composite scores were entered into the stepwise model, $F(2{,}67) = 12.77$, $p < .000$, $R^2 = .28$, $R^2_{Adjusted} = .25$. The results suggest that 83% of the variance in the *GFTA-3 SIS* scores can be accounted for by administering the *BOT-2* and the *CTOPP-2 PA* composite.

All variables were used as potential predictors of the *CTOPP-2 RAN* composite scores. The stepwise analysis indicated that *CTOPP-2 PA* was the sole significant predictor, $F(1{,}68) = 9.44$, $p < .00$, $R^2 = .12$, $R^2_{Adjusted} = .10$. The results suggest that 12% of the variance in the *CTOPP-2 RAN* scores can be accounted for by administering the *CTOPP-2 PA* composite.

All variables were used as potential predictors of the *CTOPP-2 PA* composite scores. The stepwise analysis indicated that *CTOPP-2 RAN* and the *GFTA-3 SIW* were significant predictors, $F(2{,}67) = 8.85$, $p < .00$, $R^2 = .21$, $R^2_{Adjusted} = .19$. The results suggest that 21% of the variance in the *CTOPP-2 PA* scores can be accounted for by administering the *CTOPP-2 RAN* composite and the *GFTA-3 SIW* subtest.

All variables were used as potential predictors of the *BOT-2* scores. The stepwise analysis indicated that *CTOPP-2 PA* was the sole significant predictor, $F(1,68) = 19.74$, $p < .00$, $R^2 = .23$, $R^2_{Adjusted} = .21$. The results suggest that 23% of the variance in the *CTOPP-2 RAN* scores can be accounted for by administering the *CTOPP-2 PA* composite.

Correlations

To investigate the relationships among the data that were obtained, a Pearson product-moment correlation analysis was conducted. Results of the correlation are presented in Table 2. Significant findings were found among many of the variables.

Table 2. *Correlations Among Predictors*

	CTOPP-2 PA	**CTOPP-2 RAN**	**GFTA-2 SIW**	**GFTA-2 SIS**
CTOPP-2 PA	-			
CTOPP-2 RAN	.35*	-		
GFTA-3 SIW	.34*	.13	-	
GFTA-3 SIS	.35*	.21	.91*	-
BOT-2	.27	.26	.47*	.47*

Note. N = 70. * indicates significance at the 0.05 level.

Chapter V

Discussion

Interpretation and Implications

The present study examined the PA, RAN, and non-speech-based motoric abilities of 70 early school-age children to determine if any variables were significantly related to speech sound abilities. The results showed that PA and speech sound abilities demonstrated a weak correlation, which is consistent with previous research (Sutherland & Gillon, 2005). However, it should be noted that Webster and Plante (1992b) reported a moderate relationship between the two constructs. One possible reason for slightly differing results is that the current study comprised a randomized sample of participants with varying articulatory abilities, whereas Webster and Plante (1992b) specifically examined children with a severe PD. In addition, the present study utilized differing PA tasks, which may have also contributed to a weaker correlation. Furthermore, a relationship between PA and speech sound proficiency was established, which aligns with accumulating evidence suggesting that children with isolated SSD (Bird et al., 1995; Rvachew et al., 2003) and SSD with comorbid LI (Lewis et al. 2000; Sices et al., 2007) are at heightened risk for demonstrating reading deficits. Two primary clinical implications can be drawn from the present finding. That is, the SSD diagnostic evaluation should consider all communication domains to identify any potential co-occurring deficits, and the implementation of literacy tasks to the SSD treatment regimen may mitigate potential literacy deficits.

Cumulative research examining the relationship between RAN and speech sound abilities is somewhat equivocal. Furthermore, the present study revealed no significant correlation between RAN and speech sound proficiency, which is in agreement with data reported by Raitano et al. (2004) and Tambyraja et al. (2020). However, some investigators (Leitao et al., 1997; Preston, 2008) have noted a significant correlation between the two constructs. Perhaps, methodological differences in quantifying articulation and RAN proficiency contributed to the data discrepancies among the investigations. A weak relationship between PA and speech sound abilities suggests that if children exhibit below average abilities in one area, they are at risk for struggling in the other area. However, it should not be assumed that if children perform poorly in one area, they will also be low in the other area. Moreover, RAN and PA should not be used as a proxy for one another.

Statistical analyses revealed a weak correlation between PA and RAN, suggesting the two constructs may represent separate skills. This finding is relatively consistent with previous evidence documenting a mild to moderate relationship between the two variables (Georgiou et al., 2008; Manis et al., 2000). Wolf and Bowers (1999) postulated that RAN and PA are two distinct abilities that uniquely contribute to different aspects of reading. Furthermore, differential underlying cognitive mechanisms likely underlie these constructs. The present study's findings support this theory and signify the necessity of assessing both RAN and PA in the current study’s targeted age range. Speeded naming assessments are quick to administer and predictive of future reading abilities independent of PA (Manis et al., 2000; Powell & Atkinson, 2021), thus further supporting the inclusion of RAN in the SSD diagnostic battery.

A somewhat unanticipated finding was the very strong correlation among the GFTA-3 (Goldman & Fristoe, 2015) SIW and SIS subtests. To date, no studies have specifically investigated the correlation between a standardized assessment’s citation and connected speech subtests. However, Johnson et al., 1980 examined children’s speech errors using the GFTA (Goldman & Fristoe, 1972) and found the SIS subtest to evidence significantly more articulatory errors than the SIW subtest. The present study only considered composite scores in the analysis of the results; thus, the frequency and type of articulatory errors produced in single words and connected speech was not examined. Furthermore, the current results signify a robust association between the GFTA-3 (Goldman & Fristoe, 2015) SIW and SIS subtests, suggesting that both subtests are predictive of the same abilities. It is possible that administering both subtests is not providing any additional information that could be obtained from just one of the subtests. In essence, the administration of a second GFTA-3 (Goldman & Fristoe, 2015) subtest is not likely to change a child's eligibility status. This finding is clinically pertinent, particularly to school-based SLPs, due to increased time constraints for diagnostic evaluations. Empirical research has established that conversational speech samples provide valuable information regarding children's speech and linguistic abilities (Klein & Liu-shea, 2009; Masterson et al., 2005). Thus, SLPs may consider collecting a brief SLS to gather a complete summation of a child's overall communication status.

There is a paucity of research that is explicitly dedicated to investigating the relationship between speech sound proficiency and motoric abilities. The current study aimed to augment the growing body of literature examining the communicative and motoric relationship, specifically, the potential speech-motor link. Moreover, data revealed a moderate correlation between speech sound abilities and non-speech-based motoric skills. This finding supports past research (Rechetnikov & Maitra, 2009) documenting a significant association between speech and/or LIs and motoric deficits. The BOT-2 (Bruininks & Bruininks, 2005) short test evaluated a wide range of fine and gross motor skills; however, specific motor abilities were not considered, as a single composite score was used to quantify the participants' overall motoric proficiency. Thus, a correlation concerning specific types of motor deficiencies could not be surmised, although current results suggest a speech-motor link. A moderate correlation between motor and speech suggests that difficulties in these areas are commonly comorbid.

The present findings lead to several clinical implications for SLPs that serve early school-age children. Research shows that handwriting is highly related to academic achievement, especially composition and literacy skills (Dinehart, 2014). In fact, handwriting proficiency has been proven as a significant predictor of written composition in children with a specific LI (Connelly et al., 2012). The present results, taken together with other evidence (Newmeyer et al., 2007), suggest a significant relationship between speech and motoric abilities. Thus, the possibility that children with SSD may be at risk for academic consequences precipitated by handwriting deficits should be considered. The incorporation of supplementary handwriting practice into treatment could serve as an avenue to foster speech, language, and fine motor skills simultaneously. Due to a moderate relationship between articulatory and motoric abilities, a rudimentary motor screening tool should also be considered during the SSD diagnostic process. Moreover, based on screening results, occupational/physical therapy referrals and comprehensive developmental testing in motor areas may be warranted if motoric impairments are suspected. Additional research on children is required to specify the relationship between speech and motor abilities or to make definitive clinical recommendations for the SSD population.

Limitations

Several limitations were evident in the present study. A relatively small sample size was used to investigate potential correlates related to speech sound abilities, thus reducing the generalizability of the study's findings. All participants were from southeastern Georgia; therefore, results may not be representative of children residing in other regions of the nation. A large proportion of the participants attended the Coastal Plain Head Start or Boys and Girls Club, which are partially government-funded organizations established to assist families with significant financial needs. Consequently, it is possible that an overrepresentation of children from low SES may have biased the results.

Dialectical differences were not considered when scoring the GFTA-3 (Goldman & Fristoe, 2015), which may have affected some participants' articulatory proficiency scores. Although the current sample included various levels of speech sound proficiency, there was an underrepresentation of children with below-average speech sound abilities. Thus, the sample composition likely limited the applicability of the results to the SSD population. Time constraints were another potential limitation of the present investigation. Most participants completed all assessments within one session; thus, fatigue may have adversely impacted performance towards the end of the testing session. However, all tests were counterbalanced to avoid fatigue systematically impacting performance on a particular test.

Recommendations

A prospective study should comprise a larger sample of participants and encompass more children with an SSD diagnosis, as well as an age-matched control group for comparative purposes. A larger sample size would permit greater in-depth analyses of the relationships between the correlational variables, thus, providing a comprehensive summation of which variables are most likely associated with SSD. These analyses would allow for more definitive recommendations to be made regarding the evaluation and treatment of SSD. Furthermore, the current study did not distinguish between the different classifications of speech sound errors, such as distortions, typical errors, and atypical errors. Future studies might examine if there is a relationship between the specific type of speech sound error and non-speech-based-motoric abilities. Research suggests that children with idiosyncratic speech errors are at higher risk for developing RD (Foy & Mann, 2011), thus it would be notable to establish if there is also a significant correlation between atypical errors and motoric performance. This information may clue clinicians about which children are more likely to demonstrate non-speech-based motoric deficits.

The results of the present study suggested that no additional information is obtained from administering a second GFTA-3 (Goldman & Fristoe, 2015) subtest. However, an error pattern analysis was not completed on the participants' responses. A future study might also examine the frequency and type of errors produced in the SIW and SIS subtests to investigate the similarities and differences among speech errors in both subtests. If additional clinical information is identified, clinicians may consider completing an error pattern analysis on the SIW and SIS subtests to gain additional insight concerning children's speech repertoire. The current study examined children between the ages of 4 to 7; however, future investigators might evaluate an older sample of children to specify if chronological age is associated with a larger scoring discrepancy between the SIW and SIS subtests. Finally, audio recordings were not obtained in the present study; although, prospective studies may consider audio recording the participants' responses to establish interrater reliability.

There is very little published research on the relationship between speech sound abilities and motoric proficiency, thus underscoring the need for further investigation. As mentioned earlier, the present study used a standardized motor score that was representative of combined fine and gross motor performance. A future investigation could include two distinct motor measures in the research design to establish if speech sound proficiency is linked specifically to fine and/or gross motor abilities. Visuomotor skills, specifically handwriting, are associated with academic attainment (Dinehart, 2014). The present study did not evaluate handwriting in-depth when assessing motoric abilities. However, prospective studies may consider directly comparing speech sound abilities with more specific handwriting measures.

Conclusion

The present research aimed to investigate if PA, RAN, and non-speech-based motoric abilities were significantly related to speech sound proficiency. Results suggested a moderate association between speech and motoric abilities, which adds to the limited body of literature examining the speech-motor link. If future evidence supports this finding, the inclusion of a rudimentary motoric screening to the SSD diagnostic battery might be necessary. Occupational and physical therapy referrals may also be warranted. Furthermore, a weak correlation was detected between speech sound abilities and PA, as well as with PA and RAN. There was an underrepresentation of children that demonstrated below-average articulatory skills in the present study, which may have contributed to a weaker correlation among the variables. However, current results suggest that both PA and RAN need assessing, as they are two distinct abilities. In addition, findings support that SLPs should be cognizant of the relationship between articulatory and literacy proficiency. A very strong association between the GFTA-3 (Goldman & Fristoe, 2015) SIW and SIS subtests was established. This finding suggests that additional information regarding children's articulatory abilities and subsequent eligibility status is not obtained from administering a second GFTA-3 (Goldman & Fristoe, 2015) subtest. Thus, only one subtest may need administering, and instead, SLPs might consider collecting an informal connected speech sample to gain better insight into children's speech and linguistic profile. Future studies might examine speech error types and specific motor skills in children with SSD, thus allowing for conclusive recommendations to be made regarding testing, therapy, and referrals.

References

Alcock, K., & Connor, S. (2021). Oral motor and gesture abilities independently associated with preschool language skill: Longitudinal and concurrent relationships at 21 months and 3–4 years. *Journal of Speech, Language, and Hearing Research*, *64*(6), 1944–1963. https://doi.org/10.1044/2021_jslhr-19-00377

Alcock, K. J., & Krawczyk, K. (2010). Individual differences in language development: Relationship with motor skill at 21 months. *Developmental Science*, *13*(5), 677–691. https://doi.org/10.1111/j.1467-7687.2009.00924.x

Anthony, J. L., Aghara, R. G., Dunkelberger, M. J., Anthony, T. I., Williams, J. M., & Zhang, Z. (2011). What factors place children with speech sound disorders at risk for reading problems? *American Journal of Speech-Language Pathology, 20*(2), 146-160. https://doi:10.1044/1058-0360(2011/10-0053)

Anthony, J. L., & Francis, D. J. (2005). Development of phonological awareness. *Current Directions in Psychological Science*, *14*(5), 255–259. https://doi.org/10.1111/j.0963-7214.2005.00376.x

Benway, N. R., Garcia, K., Hitchcock, E., McAllister, T., Leece, M. C., Wang, Q., & Preston, J. L. (2021). Associations between speech perception, vocabulary, and phonological awareness skill in school-aged children with speech sound disorders. *Journal of Speech, Language, and Hearing Research*, *64*(2), 452–463. https://doi.org/10.1044/2020_jslhr-20-00356

Bernthal, J. E., Bankson, N. W., & Flipsen, P. (2017). *Articulation and phonological disorders: Speech sound disorders in children (8th ed.)*. Pearson.

Bird, J., Bishop, D. V., & Freeman, N. H. (1995). Phonological awareness and literacy development in children with expressive phonological impairments. *Journal of Speech, Language, and Hearing Research*, *38*(2), 446–462. https://doi.org/10.1044/jshr.3802.446

Bishop, D. V. (2002). Motor immaturity and specific speech and language impairment: Evidence for a common genetic basis. *American Journal of Medical Genetics*, *114*(1), 56–63. https://doi.org/10.1002/ajmg.1630

Bishop, D. V., & Adams, C. (1990). A prospective study of the relationship between specific language impairment, phonological disorders and reading retardation. *Journal of Child Psychology and Psychiatry*, *31*(7), 1027–1050. https://doi.org/10.1111/j.1469-7610.1990.tb00844.x

Bowers, P. G. (1995). Tracing symbol naming speed's unique contributions to reading disabilities over time. *Reading and Writing*, *7*(2), 189–216. https://doi.org/10.1007/bf01027185

Bowers, P. G., & Wolf, M. (1993). Theoretical links among naming speed, precise timing mechanisms and orthographic skill in dyslexia. *Reading and Writing*, *5*(1), 69–85. https://doi.org/10.1007/bf01026919

Brookman, A., Mcdonald, S., Mcdonald, D., & Bishop, D. V. (2013). Fine motor deficits in reading disability and language impairment: Same or different? *PeerJ, 1*. https://doi:10.7717/peerj.217

Brosseau-Lapré, F., & Roepke, E. (2019). Speech errors and phonological awareness in children ages 4 and 5 years with and without speech sound disorder. *Journal of Speech, Language, and Hearing Research*, *62*(9), 3276–3289. https://doi.org/10.1044/2019_jslhr-s-17-0461

Bruininks, R. H., & Bruininks, B. D. (2005). *Bruininks-Oseretsky test of motor proficiency (2nd edition)*. Pearson. https://www.pearsonassessments.com/store/usassessments/en/Store/Professional-Assessments/Motor-Sensory/Bruininks-Oseretsky-Test-of-Motor-Proficiency-%7C-Second-Edition/p/100000648.html

Campbell, T. F., Dollaghan, C. A., Rockette, H. E., Paradise, J. L., Feldman, H. M., Shriberg, L. D., & Kurs-Lasky, M. (2003). Risk factors for speech delay of unknown origin in 3-year-old children. *Child Development, 74*(2), 346-357. https://doi:10.1111/1467-8624.7402002

Carroll, J. L., Fuller, G. B., & Lindley, K. E. (1989). Visual-motor ability of children with articulation disorders. *Perceptual and Motor Skills*, *69*(1), 32–34. https://doi.org/10.2466/pms.1989.69.1.32

Catts, H. W. (1993). The relationship between speech-language impairments and reading disabilities. *Journal of Speech and Hearing Research, 36*, 948-958 https://doi.org/10.1515/9783110879575.167

Catts, H. W., Gillispie, M., Leonard, L. B., Kail, R. V., & Miller, C. A. (2002). The role of speed of processing, rapid naming, and phonological awareness in reading achievement. *Journal of Learning Disabilities*, *35*(6), 510–525. https://doi.org/10.1177/00222194020350060301

Chard, D. J., & Dickson, S. V. (1999). Phonological awareness. *Intervention in School and Clinic*, *34*(5), 261–270. https://doi.org/10.1177/105345129903400502

Compton, D. L. (2003). Modeling the relationship between growth in rapid naming speed and growth in decoding skill in first-grade children. *Journal of Educational Psychology*, *95*(2), 225–239. https://doi.org/10.1037/0022-0663.95.2.225

Connelly, V., Dockrell, J. E., Walter, K., & Critten, S. (2012). Predicting the quality of composition and written language bursts from oral language, spelling, and handwriting skills in children with and without specific language impairment. *Written Communication*, *29*(3), 278–302. https://doi.org/10.1177/0741088312451109

Cowan, W. E., & Moran, M. J. (1997). Phonological awareness skills of children with articulation disorders in kindergarten to third grade. *Journal of Children's Communication Development*, *18*(2), 31–38. https://doi.org/10.1177/152574019701800204

Cronin, V. S. (2013). RAN and double-deficit theory. *Journal of Learning Disabilities*, *46*(2), 182–190. https://doi.org/10.1177/0022219411413544

Daly, C. J., Kelley, G. T., & Krauss, A. (2003). Relationship between visual-motor integration and handwriting skills of children in kindergarten: A modified replication study. *The American Journal of Occupational Therapy*, *57*(4), 459–462. https://doi.org/10.5014/ajot.57.4.459

Decker, S. L., Roberts, A. M., & Englund, J. A. (2013). Cognitive predictors of rapid picture naming. *Learning and Individual Differences*, *25*, 141–149. https://doi.org/10.1016/j.lindif.2013.03.009

Dewey, D. (1993). Error analysis of limb and orofacial praxis in children with developmental motor deficits. *Brain and Cognition, 23*(2), 203-221. https://doi:10.1006/brcg.1993.1055

Dinehart, L. H. (2014). Handwriting in early childhood education: Current research and future implications. *Journal of Early Childhood Literacy*, *15*(1), 97–118. https://doi.org/10.1177/1468798414522825

Dinehart, L., & Manfra, L. (2013). Associations between low-income children's fine motor skills in preschool and academic performance in second grade. *Early Education & Development*, *24*(2), 138–161. https://doi.org/10.1080/10409289.2011.636729

DuBois, E. M., & Bernthal, J. E. (1978). A comparison of three methods for obtaining articulatory responses. *Journal of Speech and Hearing Disorders*, *43*(3), 295–305. https://doi.org/10.1044/jshd.4303.295

Dworkin, J. P. (1978). Protrusive lingual force and lingual diadochokinetic rates: A comparative analysis between normal and lisping speakers. *Language, Speech, and Hearing Services in Schools*, *9*(1), 8–16. https://doi.org/10.1044/0161-1461.0901.08

Eadie, P., Morgan, A., Ukoumunne, O. C., Eecen, K. T., Wake, M., & Reilly, S. (2014). Speech sound disorder at 4 years: Prevalence, comorbidities, and predictors in a community cohort of children. *Developmental Medicine & Child Neurology, 57*(6), 578-584. https://doi:10.1111/dmcn.12635

Ercan, Z. G., Yilmaz, Ş., Taş, M., & Aral, N. (2016). Investigation of visual motor integration skills in children with speech sound problems. *Perceptual and Motor Skills*, *123*(3), 624–636. https://doi.org/10.1177/0031512516664894

Fabiano-Smith, L. (2019). Standardized tests and the diagnosis of speech sound disorders. *Perspectives of the ASHA Special Interest Groups, 4*(1), 58-66. https://doi:10.1044/2018_pers-sig1-2018-0018

Farquharson, K., & Tambyraja, S. (2019). Describing how school-based SLPS determine eligibility for children with speech sound disorders. *Seminars in Speech and Language*, *40*(02), 105–112. https://doi.org/10.1055/s-0039-1677761

Ferrari, P. F., Gallese, V., Rizzolatti, G., & Fogassi, L. (2003). Mirror neurons responding to the observation of ingestive and communicative mouth actions in the monkey ventral premotor cortex. *European Journal of Neuroscience,17*(8), 1703-1714. https://doi:10.1046/j.1460-9568.2003.02601.x

Finlay, J. C. S., & McPhillips, M. (2013). Comorbid motor deficits in a clinical sample of children with specific language impairment. *Research in Developmental Disabilities*, *34*(9), 2533–2542. https://doi.org/10.1016/j.ridd.2013.05.015

Fletcher, S. G. (1972). Time-by-count measurement of diadochokinetic syllable rate. *Journal of Speech and Hearing Research, 15*(4), 763-770. https://doi:10.1044/jshr.1504.763

Fogo, J., Spangler, S., Rose, H., White, M., Moore, J., Yeldell, C., & Struewing, R. (2020). Fine motor activities in kindergarten classrooms. *The American Journal of Occupational Therapy*, *74*(4_Supplement_1). https://doi.org/10.5014/ajot.2020.74s1-po1130

Foy, J. G., & Mann, V. A. (2011). Speech production deficits in early readers: Predictors of risk. *Reading and Writing,25*(4), 799-830. https://doi:10.1007/s11145-011-9300-4

Furnes, B., & Samuelsson, S. (2011). Phonological awareness and rapid automatized naming predicting early development in reading and spelling: Results from a cross-linguistic longitudinal study. *Learning and Individual Differences*, *21*(1), 85–95. https://doi.org/10.1016/j.lindif.2010.10.005

Georgiou, G. K., Parrila, R., Kirby, J. R., & Stephenson, K. (2008). Rapid naming components and their relationship with phonological awareness, orthographic knowledge, speed of processing, and different reading outcomes. *Scientific Studies of Reading*, *12*(4), 325–350. https://doi.org/10.1080/10888430802378518

Goldman, R., & Fristoe, M. (2015). *Goldman-Fristoe test of articulation (3rd edition).* Pearson. https://www.pearsonassessments.com/store/usassessments/en/Store/Professional-Assessments/Developmental-Early-Childhood/Goldman-Fristoe-Test-of-Articulation-3/p/100001202.html

Goldman, R., & Fristoe, M. (1972). *Goldman-Fristoe test of articulation.* American Guidance Service.

Grissmer, D., Grimm, K. J., Aiyer, S. M., Murrah, W. M., & Steele, J. S. (2010). Fine motor skills and early comprehension of the world: Two new school readiness indicators. *Developmental Psychology*, *46*(5), 1008–1017. https://doi.org/10.1037/a0020104

Healy, T. J., & Madison, C. L. (1987). Articulation error migration: A comparison of single word and connected speech samples. *Journal of Communication Disorders*, *20*(2), 129–136. https://doi.org/10.1016/0021-9924(87)90004-9

Heiser, M., Iacoboni, M., Maeda, F., Marcus, J., & Mazziotta, J. C. (2003). The essential role of Broca's area in imitation. *European Journal of Neuroscience, 17*(5), 1123-1128. https://doi:10.1046/j.1460-9568.2003.02530.

Hill, E. L. (2001). Non-specific nature of specific language impairment: A review of the literature with regard to concomitant motor impairments. *International Journal of Language & Communication Disorders, 36*(2), 149-171. https://doi:10.1080/13682820010019874

Hoffman, P. R., & Norris, J. A. (2002). Phonological assessment as an integral part of language assessment. *American Journal of Speech-Language Pathology, 11*(3), 230-235. https://doi:10.1044/1058-0360(2002/024)

Hulme, C., Hatcher, P. J., Nation, K., Brown, A., Adams, J., & Stuart, G. (2002). Phoneme awareness is a better predictor of early reading skill than onset-rime awareness. *Journal of Experimental Child Psychology*, *82*(1), 2–28. https://doi.org/10.1006/jecp.2002.2670

Itagi, A., Baby, C. J., Rout, S., Bharath, K. P., Karthik, R., & Kumar, M. R. (2018). Lisp detection and correction based on feature extraction and random forest classifier. *Lecture Notes in Electrical Engineering Microelectronics, Electromagnetics and Telecommunications,* 55-64. https://doi:10.1007/978-981-13-1906-8_6

Iverson, J. M. (2010). Developing language in a developing body: The relationship between Motor Development and Language Development. *Journal of Child Language*, *37*(2), 229–261. https://doi.org/10.1017/s0305000909990432

James, K. H., & Engelhardt, L. (2012). The effects of handwriting experience on functional brain development in pre-literate children. *Trends in Neuroscience and Education*, *1*(1), 32–42. https://doi.org/10.1016/j.tine.2012.08.001

Jenkins, E., & Lohr, F. E. (1964). Severe articulation disorders and motor ability. *Journal of Speech and Hearing Disorders*, *29*(3), 286–292. https://doi.org/10.1044/jshd.2903.286

Johnson, J. P., Winney, B. L., & Pederson, O. T. (1980). Single word versus connected speech articulation testing. *Language, Speech, and Hearing Services in Schools*, *11*(3), 175–179. https://doi.org/10.1044/0161-1461.1103.175

Jones, D., & Christensen, C. A. (1999). Relationship between automaticity in handwriting and students' ability to generate written text. *Journal of Educational Psychology*, *91*(1), 44–49. https://doi.org/10.1037/0022-0663.91.1.44

Katzir, T., Kim, Y.-S., Wolf, M., Morris, R., & Lovett, M. W. (2008). The varieties of pathways to dysfluent reading. *Journal of Learning Disabilities*, *41*(1), 47–66. https://doi.org/10.1177/0022219407311325

Khan, L., & Lewis, N. (2015) *Khan-Lewis Phonological Analysis (3rd edition).* Pearson. https://www.pearsonassessments.com/store/usassessments/en/Store/Professional-Assessments/Developmental-Early-Childhood/Khan-Lewis-Phonological-Analysis-%7C-Third-Edition/p/100001242.html

Kim, Y.-S., Puranik, C., & Otaiba, S. A. (2015). Developmental trajectories of writing skills in first grade. *The Elementary School Journal*, *115*(4), 593–613. https://doi.org/10.1086/681971

Kirby, J. R., Parrila, R. K., & Pfeiffer, S. L. (2003). Naming speed and phonological awareness as predictors of reading development. *Journal of Educational Psychology*, *95*(3), 453–464. https://doi.org/10.1037/0022-0663.95.3.453

Klein, H. B., & Liu-Shea, M. (2009). Between-word simplification patterns in the continuous speech of children with speech sound disorders. *Language, Speech, and Hearing Services in Schools*, *40*(1), 17–30. https://doi.org/10.1044/0161-1461(2008/08-0008)

Leitao, S., & Fletcher, J. (2004). Literacy outcomes for students with speech impairment: Long-term follow-up. *International Journal of Language & Communication Disorders*, *39*(2), 245–256. https://doi.org/10.1080/13682820310001619478

Leitao, S., Hogben, J., & Fletcher , J. (1997). Phonological processing skills in speech and language impaired children. *International Journal of Language & Communication Disorders*, *32*(2s), 91–111. https://doi.org/10.1111/j.1460-6984.1997.tb01626.x

Lewis, B. A., Avrich, A. A., Freebairn, L. A., Hansen, A. J., Sucheston, L. E., Kuo, I., Taylor, H.G., Iyengar, S.K., & Stein, C. M. (2011). Literacy outcomes of children with early childhood speech sound disorders: Impact of endophenotypes. *Journal of Speech, Language, and Hearing Research, 54*(6), 1628-1643. https://doi:10.1044/1092-4388(2011/10-0124)

Lewis, B. A., Freebairn, L. A., & Taylor, H. G. (2000). Follow-up of children with early expressive phonology disorders. *Journal of Learning Disabilities*, *33*(5), 433–444. https://doi.org/10.1177/002221940003300504

Lonigan, C. J., Wagner, R. K., Torgesen, J. K., & Rashotte, C. (2002). *Preschool Comprehensive Test of Phonological and Print Processing*. Florida State University. https://psy.fsu.edu/~lonigan/01234Pre-CTOPPP.htm

Lovett, M. W., Steinbach, K. A., & Frijters, J. C. (2000). Remediating the core deficits of developmental reading disability. *Journal of Learning Disabilities*, *33*(4), 334–358. https://doi.org/10.1177/002221940003300406

Macrae, T., & Tyler, A. A. (2014). Speech abilities in preschool children with speech sound disorder with and without co-occurring language impairment. *Language, Speech, and Hearing Services in Schools*, *45*(4), 302–313. https://doi.org/10.1044/2014_lshss-13-0081

Manis, F. R., Doi, L. M., & Bhadha, B. (2000). Naming speed, phonological awareness, and orthographic knowledge in second graders. *Journal of Learning Disabilities, 33*(4), 325-333. https://doi:10.1177/002221940003300405

Manto, M., Bower, J. M., Conforto, A. B., Delgado-García, J. M., Guarda, S. N., Gerwig, M., Habas, C., Hagura, N., Ivry, R., Marien, P., Molinari, M., Naito, Eiichi., Nowak, D., Taib, N., Pelisson, D., Tesche, C., Tilikete, C., Timmann, D. (2011). Consensus paper: Roles of the cerebellum in motor control—The diversity of ideas on cerebellar involvement in movement. *The Cerebellum, 11*(2), 457-487. https://doi:10.1007/s12311-011-0331-9

Marr, D., Windsor, M. M., & Cermak, S. (2001). Handwriting readiness: Locatives and visuomotor skills in the kindergarten year. *Early Childhood Research and Practice, 34*(1), 1–28.

Masterson, J. J., Bernhardt, B. H., & Hofheinz, M. K. (2005). A comparison of single words and conversational speech in phonological evaluation. *American Journal of Speech-Language Pathology*, *14*(3), 229–241. https://doi.org/10.1044/1058-0360(2005/023)

McBride-Chang, C., & Manis, F. R. (1996). Structural invariance in the associations of naming speed, phonological awareness, and verbal reasoning in good and poor readers: A test of the double deficit hypothesis. *Reading and Writing*, *8*(4), 323–339. https://doi.org/10.1007/bf00395112

McLeod, S., & Baker, E. (2017). *Children's speech: An evidence-based approach to assessment and intervention.* Pearson.

McNutt, J. C. (1977). Oral sensory and motor behaviors of children with /s/ or /r/ misarticulations. *Journal of Speech and Hearing Research*, *20*(4), 694–703. https://doi.org/10.1044/jshr.2004.694

Metsala, J.L., & Ehri, L.C. (1998). Word Recognition in Beginning Literacy (1st ed.). Routledge. https://doi.org/10.4324/9781410602718

Mortimer, J., & Rvachew, S. (2008). Morphosyntax and phonological awareness in children with speech sound disorders. *Annals of the New York Academy of Sciences*, *1145*(1), 275–282. https://doi.org/10.1196/annals.1416.011

Mullen, R., & Schooling, T. (2010). The National Outcomes Measurement System for pediatric speech-language pathology. *Language, Speech, and Hearing Services in Schools*, *41*(1), 44–60. https://doi.org/10.1044/0161-1461(2009/08-0051)

Nathan, L., Stackhouse, J., Goulandris, N., & Snowling, M. J. (2004). The development of early literacy skills among children with speech difficulties. *Journal of Speech, Language, and Hearing Research*, *47*(2), 377–391. https://doi.org/10.1044/1092-4388(2004/031)

Newmeyer, A. J., Grether, S., Grasha, C., White, J., Akers, R., Aylward, C., Ishikawa, K., & Degrauw, T. (2007). Fine motor function and oral-motor imitation skills in preschool-age children with speech-sound disorders. *Clinical Pediatrics,46*(7), 604-611. https://doi:10.1177/0009922807299545

Nip, I. S. B., Green, J. R., & Marx, D. B. (2011). The co-emergence of cognition, language, and speech motor control in early development: A longitudinal correlation study. *Journal of Communication Disorders*, *44*(2), 149–160. https://doi.org/10.1016/j.jcomdis.2010.08.002

O'Reilly, A. W., Painter, K. M., & Bornstein, M. H. (1997). Relations between language and symbolic gesture development in early childhood. *Cognitive Development*, *12*(2), 185–197. https://doi.org/10.1016/s0885-2014(97)90012-5

Owen, S. E., & McKinlay, I. A. (1997). Motor difficulties in children with developmental disorders of speech and language. *Child: Care, Health and Development*, *23*(4), 315–325. https://doi.org/10.1046/j.1365-2214.1997.864864.x

Owens, R. E., Jr. (2016). *Language development: An introduction* (9th ed.). Pearson.

Pennington, B.F. (2006). From single to multiple deficit models of developmental disorders. *Cognition*, *101*(2), 385–413. https://doi.org/10.1016/j.cognition.2006.04.008

Pennington, B. F., & Bishop, D. V. (2009). Relations among speech, language, and reading disorders. *Annual Review of Psychology, 60*(1), 283-306. https://doi:10.1146/annurev.psych.60.110707.163548

Pennington, B. F., Cardoso-Martins, C., Green, P. A., & Lefly, D. L. (2001). Comparing the phonological and double deficit hypotheses for developmental dyslexia. *Reading and Writing*, *14*(7/8), 707–755. https://doi.org/10.1023/a:1012239018038

Peterson, R. L., Pennington, B. F., Shriberg, L. D., & Boada, R. (2009). What influences literacy outcome in children with speech sound disorder? *Journal of Speech, Language, and Hearing Research*, *52*(5), 1175–1188. https://doi.org/10.1044/1092-4388(2009/08-0024)

Piek, J. P., Dawson, L., Smith, L. M., & Gasson, N. (2008). The role of early fine and gross motor development on later motor and cognitive ability. *Human Movement Science*, *27*(5), 668–681. https://doi.org/10.1016/j.humov.2007.11.002

Pontart, V., Bidet-Ildei, C., Lambert, E., Morisset, P., Flouret, L., & Alamargot, D. (2013). Influence of handwriting skills during spelling in primary and lower secondary grades. *Frontiers in Psychology*, *4(1),*1-9. https://doi.org/10.3389/fpsyg.2013.00818

Powell, D., & Atkinson, L. (2021). Unraveling the links between rapid automatized naming (RAN), phonological awareness, and reading. *Journal of Educational Psychology*, *113*(4), 706–718. https://doi.org/10.1037/edu0000625

Preston, J. (2008). *Phonological processing and speech production in preschoolers with speech sound disorders* [Doctoral Dissertation, Syracuse University]. *Syracuse University Libraries.* https://surface.syr.edu/csd_etd/1

Preston, J., & Edwards, M. L. (2010). Phonological awareness and types of sound errors in preschoolers with speech sound disorders. *Journal of Speech, Language, and Hearing Research, 53*(1), 44-60. https://doi:10.1044/1092-4388(2009/09-0021)

Preston, J., Hull, M., & Edwards, M. L. (2013). Preschool speech error patterns predict articulation and phonological awareness outcomes in children with histories of speech sound disorders. *American Journal of Speech-Language Pathology*, *22*(2), 173–184. https://doi.org/10.1044/1058-0360(2012/12-0022)

Prins, T. D. (1962). Motor and auditory abilities in different groups of children with articulatory deviations. *Journal of Speech and Hearing Research*, *5*(2), 161–168. https://doi.org/10.1044/jshr.0502.161

Puranik, C. S., & Altoabia, S. (2011). Examining the contribution of handwriting and spelling to written expression in kindergarten children. *Reading and Writing*, *25*(7), 1523–1546. https://doi.org/10.1007/s11145-011-9331-x

Puranik, C. S., Lombardino, L. J., & Altmann, L. J. (2006). Writing through retellings: An exploratory study of language-impaired and dyslexic populations. *Reading and Writing*, *20*(3), 251–272. https://doi.org/10.1007/s11145-006-9030-1

Puranik, C. S., Phillips, B. M., Lonigan, C. J., & Gibson, E. (2018). Home literacy practices and preschool children's emergent writing skills: An initial investigation. *Early Childhood Research Quarterly*, *42*, 228–238. https://doi.org/10.1016/j.ecresq.2017.10.004

Raitano, N. A., Pennington, B. F., Tunick, R. A., Boada, R., & Shriberg, L. D. (2004). Pre-literacy skills of subgroups of children with speech sound disorders. *Journal of Child Psychology and Psychiatry, 45*(4), 821-835. https://doi:10.1111/j.1469-7610.2004.00275.

Rechetnikov, R. P., & Maitra, K. (2009). Motor impairments in children associated with impairments of speech or language: A meta-analytic review of research literature. *The American Journal of Occupational Therapy*, *63*(3), 255–263. https://doi.org/10.5014/ajot.63.3.255

Redle, E., Vannest, J., Maloney, T., Tsevat, R. K., Eikenberry, S., Lewis, B., Shriberg, L.D., Tkach, J., & Holland, S. K. (2015). Functional MRI evidence for fine motor praxis dysfunction in children with persistent speech disorders. *Brain Research, 1597*, 47-56. https://doi:10.1016/j.brainres.2014.11.047

Rvachew, S. (2006). Longitudinal predictors of implicit phonological awareness skills. *American Journal of Speech-Language Pathology*, *15*(2), 165–176. https://doi.org/10.1044/1058-0360(2006/016)

Rvachew, S., & Grawburg, M. (2006). Correlates of phonological awareness in preschoolers with speech sound disorders. *Journal of Speech, Language, and Hearing Research, 49*(1), 74-87. https://doi:10.1044/1092-4388(2006/006)

Rvachew, S., Ohberg, A., Grawburg, M., & Heyding, J. (2003). Phonological awareness and phonemic perception in 4-year-old children with delayed expressive phonology skills. *American Journal of Speech-Language Pathology*, *12*(4), 463–471. https://doi.org/10.1044/1058-0360(2003/092)

Shriberg, L.D. (1994). Five subtypes of developmental phonological disorders. *Clinical Communication Disorders*, *4*(1), 38-53.

Shriberg, L. D., Tomblin, J. B., & Mcsweeny, J. L. (1999). Prevalence of speech delay in 6-year-old children and comorbidity with language impairment. *Journal of Speech, Language, and Hearing Research, 42*(6), 1461-1481. https://doi:10.1044/jslhr.4206.1461

Sices, L., Taylor, H. G., Freebairn, L., Hansen, A., & Lewis, B. (2007). Relationship between speech-sound disorders and early literacy skills in preschool-age children: Impact of comorbid language impairment. *Journal of Developmental & Behavioral Pediatrics*, *28*(6), 438–447. https://doi.org/10.1097/dbp.0b013e31811ff8ca

Skahan, S. M., Watson, M., & Lof, G. L. (2007). Speech-language pathologists' assessment practices for children with suspected speech sound disorders: Results of a national survey. *American Journal of Speech-Language Pathology, 16*(3), 246-259. https://doi:10.1044/1058-0360(2007/029)

Son, S. H., & Meisels, S. J. (2006). The relationship of young children's motor skills to later school achievement. *Merrill-Palmer Quarterly*, *52*(4), 755–778. https://doi.org/10.1353/mpq.2006.0033

Sunseth, K., & Bowers, G. P. (2002). Rapid naming and phonemic awareness: Contributions to reading, spelling, and orthographic knowledge. *Scientific Studies of Reading*, *6*(4), 401–429. https://doi.org/10.1207/s1532799xssr0604_05

Sutherland, D., & Gillon, G. T. (2005). Assessment of phonological representations in children with speech impairment. *Language, Speech, and Hearing Services in Schools, 36*(4), 294-307. https://doi:10.1044/0161-1461(2005/030)

Tambyraja, S. R., Farquharson, K., & Justice, L. (2020). Reading risk in children with speech sound disorder: Prevalence, persistence, and predictors. *Journal of Speech, Language, and Hearing Research*, *63*(11), 3714–3726. https://doi.org/10.1044/2020_jslhr-20-00108

Tkach, J. A., Chen, X., Freebairn, L. A., Schmithorst, V. J., Holland, S. K., & Lewis, B. A. (2011). Neural correlates of phonological processing in speech sound disorder: A functional magnetic resonance imaging study. *Brain and Language, 119*(1), 42-49. https://doi:10.1016/j.bandl.2011.02.002

Tuomi, S. K., & Winter, N. M. (1997). Diadochokinesis and articulation impairment. *Human Communication.*

Visscher, C., Houwen , S., Moolenaar, B., Lyons, J., Scherder , E. J., & Hartman , E. (2010). Motor proficiency of 6- to 9-year-old children with speech and language problems. *Developmental Medicine & Child Neurology*, *52*(11), 254-258. https://doi.org/10.1111/j.1469-8749.2010.03774.x

Visscher, C., Houwen, S., Scherder, E. J., Moolenaar, B., & Hartman, E. (2007). Motor profile of children with developmental speech and language disorders. *Pediatrics, 120*(1), 158-163. https://doi:10.1542/peds.2006-2462

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101*(2), 192-212. https://doi:10.1037/0033-2909.101.2.192

Wagner, R., Torgesen, J., & Rashotte, C. (1999). *Comprehensive test of phonological processing.* Pro-Ed, Inc.

Wagner, R., Torgesen, J., Rashotte, C., & Pearson, N. (2013). *Comprehensive test of phonological processing (2nd edition).* Pro-Ed, Inc. *https://www.proedinc.com/Products/13080/ctopp2-comprehensive-test-of-phonological-processingsecond-edition.aspx*

Watson, M. M. (1989). Comparison of three methods for eliciting phonological processes. *Perceptual and Motor Skills*, *69*(3-1), 771–778. https://doi.org/10.1177/00315125890693-112

Webster, R. I., Majnemer, A., Platt, R. W., & Shevell, M. I. (2005). Motor function at school age in children with a preschool diagnosis of developmental language impairment. *The Journal of Pediatrics*, *146*(1), 80–85. https://doi.org/10.1016/j.jpeds.2004.09.005

Webster, P. E., & Plante, A. S. (1992a). Effects of phonological impairment on word, syllable, and phoneme segmentation and reading. *Language, Speech, and Hearing Services in Schools*, *23*(2), 176–182. https://doi.org/10.1044/0161-1461.2302.176

Webster, P. E., & Plante, A. S. (1992b). Phonologically impaired preschoolers: Rhyme with an eye toward reading. *Perceptual and Motor Skills*, *75*(3_suppl), 1195–1204. https://doi.org/10.1177/003151259207503s01

Williams, P., & Stackhouse, J. (1998). Diadochokinetic skills: Normal and atypical performance in children aged 3–5 years. *International Journal of Language & Communication Disorders, 33*(S1), 481-486. https://doi:10.3109/13682829809179472

Windsor, J., Scott, C. M., & Street, C. K. (2000). Verb and noun morphology in the spoken and written language of children with language learning disabilities. *Journal of Speech, Language, and Hearing Research*, *43*(6), 1322–1336. https://doi.org/10.1044/jslhr.4306.1322

Wolf, M. (1986). Rapid alternating stimulus naming in the developmental dyslexias. *Brain and Language*, *27*(2), 360–379. https://doi.org/10.1016/0093-934x(86)90025-8

Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology*, *91*(3), 415–438. https://doi.org/10.1037/0022-0663.91.3.415

Wolf, M., Bowers, P. G., & Biddle, K. (2000). Naming-speed processes, timing, and reading. *Journal of Learning Disabilities*, *33*(4), 387–407. https://doi.org/10.1177/002221940003300409

Wolf, M., O'Rourke, A. G., Gidney, C., Lovett, M., Cirino, P., & Morris, R. (2002). The second deficit: An investigation of the independence of phonological and naming-speed deficits in developmental dyslexia. *Reading and Writing*, *15*(1/2), 43–72. https://doi.org/10.1023/a:1013816320290

Wolff, P. H., Michel, G. F., Ovrut, M., & Drake, C. (1990). Rate and timing precision of motor coordination in developmental dyslexia. *Developmental Psychology, 26*(3), 349-359. https://doi:10.1037/0012-1649.26.3.349

Yeh, L.-L., & Liu, C.-C. (2021). Comparing the informativeness of single-word samples and connected speech samples in assessing speech sound disorders. *Journal of Speech, Language, and Hearing Research*, *64*(11), 4071–4084. https://doi.org/10.1044/2021_jslhr-20-00172

Appendix A

Institutional Review Board Approval

Institutional Review Board (IRB)
for the Protection of Human Research Participants

EXPEDITED PROTOCOL APPROVAL

Protocol Number: IRB-04074-2020

Responsible Researcher: Dr. Matthew Carter

Co-Investigator: Mary Allison Moody

Project Title*: Examining the Relationship Between Diadochokinetic Rate, Phonological Awareness, Rapid Automatized Naming, and Motoric Abilities in Early School-Aged Children with a Speech Sound Disorder.*

Level of Risk: ☒ Minimal ☐ More than Minimal

Type of Review: ☒ Expedited ☐ Convened (Full Board)

Approval Category: 7

Approval Date: 09.29.2020

Expiration Date: 09.29.2023

Consent Requirements:

- ☐ Adult Participants – Written informed consent with documentation (signature)
- ☐ Adult Participants – Written informed consent with waiver of documentation (signature)
- ☐ Adult Participants – Verbal informed consent (Research Statement)
- ☐ Adult Participants – Waiver of informed consent
- ☒ Minor Participants – Written parent/guardian permission with documentation (signature)
- ☐ Minor Participants – Written parent/guardian permission with waiver of documentation (signature)
- ☐ Minor Participants – Verbal parent/guardian permission
- ☐ Minor Participants – Waiver of parent/guardian permission
- ☐ Minor Participants – Written assent with documentation (signature)
- ☒ Minor Participants – Written assent with waiver of documentation (signature)
- ☐ Minor Participants – Verbal assent
- ☐ Minor Participants – Waiver of assent
- ☐ Waiver of some elements of consent/permission/assent

Approval: This research protocol is **approved.** Your approved consent form(s), with IRB approval stamp are attached. If you prefer the original stamped consent, please email tmwright@valdosta.edu and the form will be sent via inter-office mail, or you may come by the OSPRA office to obtain the original. Please see page 2 for additional important information for researchers.

Comments:

Elizabeth Ann Olphie *09.29.2020*

Elizabeth Ann Olphie, IRB Administrator Date

Thank you for submitting an IRB application.

Please direct questions to irb@valdosta.edu or 229-253-2947.

Form Revised: 06.02.16

EXPEDITED PROTOCOL APPROVAL REPORT

Attachment 1

ADDITIONAL INFORMATION FOR RESEARCHERS:

If your protocol received expedited approval, it was reviewed by a two-member team, or, in extraordinary circumstances, the Chair or the Vice-Chair of the IRB. Although the expediters may approve protocols, they are required by federal regulation to report expedited approvals at the next IRB meeting. At that time, other IRB members may express any concerns and may occasionally request minor modifications to the protocol. In rare instances, the IRB may request that research activities involving participants be halted until such modifications are implemented. Should this situation arise, you will receive an explanatory communiqué from the IRB.

Protocol approvals are generally valid for three years. In rare instances, when a protocol is determined to place participants at more than minimal risk, the IRB may shorten the approval period so that protocols are reviewed more frequently, allowing the IRB to reassess the potential risks and benefits to participants. The expiration date of your protocol approval is noted on the approval form. You will be contacted no less than one month before this expiration date and will be asked to either submit a final report if the research is concluded or to apply for a continuation of approval. It is your responsibility to submit a continuation request in sufficient time for IRB review before the expiration date. If you do not secure a protocol approval extension prior to the expiration date, you must stop all activities involving participants (including interaction, intervention, data collection, and data analysis) until approval is reinstated.

Please be reminded that you are required to seek approval of the IRB before amending or altering the scope of the project or the research protocol or implementing changes in the approved consent process/forms. You are also required to report to the IRB, through the Office of Sponsored Programs & Research Administration, any unanticipated problems or adverse events that become apparent during the course or as a result of the research and the actions you have taken.

Please refer to the IRB website (https://www.valdosta.edu/academics/graduate-school/research/office-of-sponsored-programs-research-administration/institutional-review-board-irb-for-the-protection-of-human-research-participants.php) for additional information about Valdosta State University's human protection program and your responsibilities as a researcher.

Form Revised: 04.10.2012

Appendix B

Research Flyer

Research Participants Needed!!

WHO: Children ages 4-7 years old

WHERE: VSU Speech & Hearing Clinic, Sullivan Literacy Center, Boys & Girls Clubs, Etc.

PARTICIPATION TIME: 1 hour and 30 minutes

BENEFITS: Detailed summary discussing child's motor and speech skills. Also, payment of $10 will be given to your child!!!

COVID-19 precautions will be followed

by all researchers

If interested, please contact either of the following:

-Mary Allison Moody, BSEd: mamoody@valdosta.edu

-Matthew Carter, PhD, CCC-SLP: mdcarter@valdosta.edu

This study has been approved by the Valdosta State University Institutional Review Board (IRB) for the Protection of Human Research Participants. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-333-7837 or irb@valdosta.edu.

Appendix C

Institutional Review Board Parent Consent

VALDOSTA STATE UNIVERSITY

Parent/Guardian Permission for Child's/Ward's Participation in Research

You are being asked to allow your child (or ward) to participate in a research study entitled "Examining the Relationship Between Diadochokinetic Rate, Phonological Awareness, Rapid Automatized Naming, and Motoric Abilities in Early School-Aged Children with a Speech Sound Disorder." This research project is being conducted by Dr. Matt Carter, a faculty member in Communication Sciences and Disorders at Valdosta State University and Mary Allison Moody, a graduate student in Communication Sciences and Disorders at Valdosta State University. The purpose of this research is to better understand speech sound disorders. Your child's participation in this study is entirely voluntary. From this point on in this form, the term "child" is used for either a child or a ward.

As described in more detail below, we will ask your child to answer questions, repeat words, perform simple motor tasks, and draw pictures. Your child's participation will last approximately 1.5 hours. Someone in your position might be interested in allowing your child to participate because it may indicate that there are relationships between these abilities, which may help us learn how to help and treat children with speech sound disorders in the future. In addition to this, your child will receive $10 for participating in this research study. There are no risks associated with this study. It is important for you to know that you or your child may discontinue participation at any time during this study.

This form includes detailed information to help you decide whether to participate in this study. Please read it carefully and ask any questions that you have before you agree to participate. Please be sure to retain a copy of this form for your records.

Procedures:

Your child will spend about 30 minutes with me completing the Comprehensive Test of Phonological Processing-Second Edition. This is a standardized test measuring phonological processing abilities, and it will take approximately 30 minutes to complete. Then, I will administer the Goldman-Fristoe Test of Articulation-Third Edition. This is a standardized test measuring articulation ability, and it will take approximately 20 minutes to complete. Next, I will administer the Developmental Indicators for the Assessment of Learning-Fourth Edition. This standardized screener assesses language and motoric abilities, and it will take approximately 30 minutes to complete. Then, I will administer a diadochokinetic syllable rate screener. This screener measures oral motor efficiency, and it will take approximately 5 minutes to complete. Finally, I will administer an apraxia/dysarthria screener. This screener is used to rule out potential presence or absence of apraxia and dysarthria. This screener will take approximately 5 minutes to complete. A graduate clinician will administer the tests and work with the parents on filling out needed paperwork. Data for each participant will be collected on a single visit. In total, the tests and screeners will take approximately 1.5 hours to complete. Using clinical judgment, play breaks will be provided as needed. Following the administration of the tests, no further participation is needed from the participants and families. This study involves research. There are no alternatives to the experimental procedures in this study. The only alternative is for you to choose not to allow your child to participate.

Possible Risks or Discomfort:

The repeated use of tests and stimulus items between participants can pose as a risk of germ contamination between participants during test administration. The surfaces of tests and stimulus items will be disinfected after each session. Face masks will be required when appropriate. In addition, the participants will be encouraged to wash their hands before and after each session. By agreeing to participate in this research project, you are not *waiving any rights that you or your child may have against Valdosta State University for injury resulting from negligence of the University or its researchers.*

Potential Benefits:

Although you will not benefit directly from this research, your participation will help the researcher gain additional understanding of the comorbid relationships associated with speech sound disorders. Knowledge gained will add to the literature of childhood speech sound disorders. In addition to this, your child will receive $10 for participating in this research study.

Costs and Compensation:

There are no costs to you and there is no compensation (no money, gifts, or services) for your participation in this research project.

Assurance of Confidentiality:

Valdosta State University and the researcher will keep your child's information confidential to the extent allowed by law. Members of the Institutional Review Board (IRB), a university committee charged with reviewing research to ensure the rights and welfare of research participants, may be given access to your child's confidential information. Your child will be assigned a code number as a way to identify and keep track of data. Numbers assigned to your child with not be associated with his/her name or any other identifying information. This is to ensure that individuals remain unidentifiable. Your child's birth date will be recorded as a way to calculate your child's chronological age in order to interpret scores and results of this study. All information obtained from testing will be kept in the researcher's office secured by lock and key. Data from this study will be reported in combination with testing information obtained from other participants. None of the participants will be identified in this study by name or birth date.

Voluntary Participation:

Your decision to allow your child to participate in this research project is entirely voluntary. If you agree now to allow your child to participate and you change your mind later, you are free to withdraw your child from the study at that time. By not allowing your child to participate in this study or by withdrawing him/her from the study before the research is complete, you are not giving up any rights that you or your child have or any services to which you or your child are otherwise entitled to from Valdosta State University. If you decide to withdraw your child from the study after data collection is complete, your child's information will be deleted from the database and will not be included in research results.

Information Contacts:

Questions regarding the purpose or procedures of the research should be directed to ***Dr. Matt Carter** at **mdcarter@valdosta.edu.*** *This study has been approved by the Valdosta State University Institutional Review Board (IRB) for the Protection of Human Research Participants. The IRB, a university committee established by Federal law, is responsible for protecting the rights and welfare of research participants. If you have concerns or questions about your rights as a research participant, you may contact the IRB Administrator at 229-253-2947 or irb@valdosta.edu.*

Agreement to Participate:

The research project and my child's (or ward's) role in it have been explained to me, and my questions have been answered to my satisfaction. I grant permission for my child to participate in this study. By signing this form, I am indicating that I am either the custodial parent or legal guardian of the child. I have received a copy of this permission form.

I would like to receive a copy of the results of this study: _____ *Yes* _____ *No*

Mailing Address: ____

E-mail Address: ______________________________

____
Printed Name of Child/Ward

____
Printed Name of Parent/Guardian

____
Signature of Parent/Guardian *Date*

____
Signature of Person Obtaining Consent *Date*

This research project has been approved by the Valdosta State University Institutional Review Board for the Protection of Human Research Participants through the date noted below:

(Revised 01.21.2019)
Permission for Child Participation in Research – Page 3 of 3 Parent/Guardian's Initials: ________

Appendix D

Institutional Review Board Child Assent

Hi. My name is ***Mary Allison Moody***. I'm a ***graduate student at Valdosta State University.*** Right now, I'm doing a research study about **speech sound disorders.** I would like to ask you to help me by being in my study, but before I do, I want to explain what will happen if you decide to help me.

I will ask you to ***answer questions, point to pictures, repeat words, and draw pictures. There are no right or wrong answers. By being in the study, you will help me understand the relationship between diadochokinetic rate, phonological awareness, rapid automatized naming, and motoric abilities in early school-aged children with a speech sound disorder.***

Your ***parents, teacher, classmates*** will not know what you have ***said, written, drawn, or chosen***. When I tell other people about my study, I will not use your name, and no one will be able to tell who I'm talking about.

Your ***mom/dad*** has said that it is okay for you to be in my study. However, if you don't want to be in the study, you don't have to be. What you decide won't make any difference ***with what people think about you,*** and I won't be upset, and no one else will be upset if you don't want to be in the study. If you're going to be in the study now but change your mind later, that's okay. You can stop at any time. If there is anything you don't understand, you should tell me so I can explain it to you

You can ask me questions about the study. If you have a problem later that you don't think of now, you can call me or ask ***your parents or teacher*** to call me or send me an email.

Do you have any questions for me now?

Would you like to be in my study and ***talk to me, answer some questions, and draw some pictures?***

NOTES TO RESEARCHER: The child (under age 18) must answer "**Yes**" or "**No**." Only a definite "**Yes**" may be taken as assent to participate.

Name of Student: ______________________________ **Parental Permission on File:** ☐ Yes ☐ No
(If "No," do not proceed with assent or research procedures.)

Student's Voluntary Response to Participation: ☐ Yes ☐ No

Signature of Researcher: ______________________________ **Date:** __________________

Appendix E

Individual Participant Data

General Information

Participant	1
Date of Birth	12/14/15
Chronological Age	5;0
Sex	Male
Test Date	1/12/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	50%	10	**Average**
Blending Words	25%	8	**Average**
Sound Matching	25%	8	**Average**
Rapid Color Naming	25%	8	**Average**
Rapid Object Naming	16%	7	**Below Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	30%	92	**Average**
Rapid Naming	16%	85	**Below Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 85-115)	Descriptive Term
Sounds-in-Words	88%	118	**Average**
Sounds-in-Sentences	90%	119	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	62%	53	**Average**

General Information

Participant	2
Date of Birth	3/19/15
Chronological Age	5;10
Sex	Female
Test Date	1/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	75%	12	**Average**
Blending Words	75%	12	**Average**
Sound Matching	75%	12	**Average**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	82%	114	**Above Average**
Rapid Naming	61%	104	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	1%	65	**Severe**
Sounds-in-Sentences	7%	78	**Borderline**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	16%	40	**Below Average**

General Information

Participant	3
Date of Birth	2/25/13
Chronological Age	7;11
Sex	Male
Test Date	2/10/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	16%	7	**Below Average**
Blending Words	25%	8	**Average**
Phoneme Isolation	50%	10	**Average**
Rapid Digit Naming	16%	7	**Below Average**
Rapid Letter Naming	16%	7	**Below Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	25%	90	**Average**
Rapid Naming	12%	82	**Below Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	19%	87	**Average**
Sounds-in-Sentences	34%	94	**Below Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	18%	41	**Average**

General Information

Participant	4
Date of Birth	11/4/13
Chronological Age	7;3
Sex	Male
Test Date	2/11/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	95%	15	**Superior**
Blending Words	91%	14	**Above Average**
Phoneme Isolation	37%	9	**Average**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	89%	118	**Above Average**
Rapid Naming	61%	104	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	82%	114	**Average**
Sounds-in-Sentences	93%	122	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	16%	40	**Below Average**

General Information

Participant	5
Date of Birth	1/4/14
Chronological Age	6;3
Sex	Female
Test Date	2/23/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	63%	11	**Average**
Blending Words	16%	7	**Average**
Sound Matching	95%	15	**Superior**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	68%	107	**Average**
Rapid Naming	61%	104	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	82%	114	**Average**
Sounds-in-Sentences	81%	113	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	93%	65	**Above Average**

General Information

Participant	6
Date of Birth	8/18/14
Chronological Age	6;6
Sex	Male
Test Date	3/4/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	50%	10	**Average**
Blending Words	98%	16	**Superior**
Sound Matching	50%	10	**Average**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	82%	114	**Above Average**
Rapid Naming	53%	101	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	27%	91	**Average**
Sounds-in-Sentences	58%	103	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	24%	43	**Average**

General Information

Participant	7
Date of Birth	9/24/13
Chronological Age	7;5
Sex	Male
Test Date	3/5/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	91%	14	**Above Average**
Phoneme Isolation	37%	9	**Average**
Rapid Digit Naming	75%	12	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	58%	103	**Average**
Rapid Naming	68%	107	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	82%	114	**Average**
Sounds-in-Sentences	93%	122	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	84%	60	**Above Average**

General Information

Participant	8
Date of Birth	4/4/13
Chronological Age	7;11
Sex	Male
Test Date	3/5/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	63%	11	**Average**
Blending Words	37%	9	**Average**
Phoneme Isolation	63%	11	**Average**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	37%	9	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	58%	103	**Average**
Rapid Naming	45%	98	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	61%	104	**Average**
Sounds-in-Sentences	87%	117	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	54%	51	**Average**

General Information

Participant	9
Date of Birth	3/26/15
Chronological Age	5;11
Sex	Female
Test Date	3/15/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	50%	10	**Average**
Blending Words	16%	7	**Below Average**
Sound Matching	9%	6	**Below Average**
Rapid Color Naming	1%	3	**Very Poor**
Rapid Object Naming	9%	6	**Below Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	18%	86	**Below Average**
Rapid Naming	1%	67	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	2%	69	**Severe**
Sounds-in-Sentences	5%	76	**Low**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	27%	44	**Average**

General Information

Participant	10
Date of Birth	10/28/14
Chronological Age	6;4
Sex	Female
Test Date	3/18/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	37%	9	**Average**
Sound Matching	84%	13	**Above Average**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	75%	12	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	50%	100	**Average**
Rapid Naming	75%	110	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	55%	102	**Average**
Sounds-in-Sentences	79%	112	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	73%	56	**Average**

General Information

Participant	11
Date of Birth	1/10/14
Chronological Age	7;2
Sex	Male
Test Date	3/10/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	95%	15	**Superior**
Blending Words	50%	10	**Average**
Phoneme Isolation	25%	8	**Average**
Rapid Digit Naming	37%	9	**Average**
Rapid Letter Naming	37%	9	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	68%	107	**Average**
Rapid Naming	37%	95	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	84%	115	**Above Average**
Sounds-in-Sentences	87%	117	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	95%	66	**Above Average**

General Information

Participant	12
Date of Birth	9/23/14
Chronological Age	6;6
Sex	Male
Test Date	3/23/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	<1%	2	**Very Poor**
Blending Words	5%	5	**Poor**
Sound Matching	1%	3	**Very Poor**
Rapid Digit Naming	5%	5	**Poor**
Rapid Letter Naming	16%	7	**Below Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	<1%	58	**Very Poor**
Rapid Naming	5%	76	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	<.1%	48	**Severe**
Sounds-in-Sentences	1%	63	**Severe**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	7%	35	**Below Average**

General Information

Participant	13
Date of Birth	2/15/15
Chronological Age	6;1
Sex	Female
Test Date	3/25/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	25%	8	**Average**
Blending Words	37%	9	**Average**
Sound Matching	37%	9	**Average**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	63%	11	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	30%	92	**Average**
Rapid Naming	68%	107	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	37%	95	**Average**
Sounds-in-Sentences	50%	100	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	10%	37	**Below Average**

General Information

Participant	14
Date of Birth	5/16/13
Chronological Age	7;10
Sex	Male
Test Date	4/1/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	95%	15	**Superior**
Blending Words	37%	9	**Average**
Phoneme Isolation	25%	8	**Average**
Rapid Digit Naming	37%	9	**Average**
Rapid Letter Naming	25%	8	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	63%	105	**Average**
Rapid Naming	30%	92	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	79%	112	**Average**
Sounds-in-Sentences	87%	117	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	62%	53	**Average**

General Information

Participant	15
Date of Birth	4/7/15
Chronological Age	5;11
Sex	Male
Test Date	4/5/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	50%	10	**Average**
Sound Matching	50%	10	**Average**
Rapid Digit Naming	37%	9	**Average**
Rapid Letter Naming	37%	9	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	39%	96	**Average**
Rapid Naming	37%	95	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	53%	101	**Average**
Sounds-in-Sentences	73%	109	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	76%	57	**Average**

General Information

Participant	16
Date of Birth	7/29/13
Chronological Age	7;8
Sex	Female
Test Date	4/7/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	25%	8	**Average**
Blending Words	63%	11	**Average**
Phoneme Isolation	63%	11	**Average**
Rapid Digit Naming	37%	9	**Average**
Rapid Letter Naming	25%	8	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	50%	100	**Average**
Rapid Naming	30%	92	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	47%	99	**Average**
Sounds-in-Sentences	45%	98	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	16%	40	**Below Average**

General Information

Participant	17
Date of Birth	1/19/16
Chronological Age	5;3
Sex	Male
Test Date	4/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	9%	6	**Below Average**
Sound Matching	16%	7	**Below Average**
Rapid Color Naming	<1%	2	**Very Poor**
Rapid Object Naming	5%	5	**Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	%	82	**Below Average**
Rapid Naming	%	61	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	55%	102	**Average**
Sounds-in-Sentences	77%	111	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	62%	53	**Average**

General Information

Participant	18
Date of Birth	1/15/16
Chronological Age	5;3
Sex	Female
Test Date	4/22/16

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	5%	4	**Poor**
Blending Words	2%	5	**Poor**
Sound Matching	16%	7	**Below Average**
Rapid Color Naming	2%	4	**Poor**
Rapid Object Naming	37%	9	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	3%	71	**Poor**
Rapid Naming	8%	79	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	18%	86	**Average**
Sounds-in-Sentences	47%	99	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	31%	45	**Average**

General Information

Participant	19
Date of Birth	2/20/16
Chronological Age	5;2
Sex	Female
Test Date	4/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	5%	5	**Poor**
Blending Words	5%	5	**Poor**
Sound Matching	37%	9	**Average**
Rapid Digit Naming	75%	12	**Average**
Rapid Letter Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	6%	77	**Poor**
Rapid Naming	75%	110	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	25%	90	**Average**
Sounds-in-Sentences	42%	97	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	46%	49	**Average**

General Information

Participant	20
Date of Birth	10/27/15
Chronological Age	5;6
Sex	Male
Test Date	4/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	2%	4	**Poor**
Blending Words	5%	5	**Poor**
Sound Matching	5%	5	**Poor**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	1%	67	**Very poor**
Rapid Naming	53%	101	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	30%	92	**Average**
Sounds-in-Sentences	61%	104	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	18%	41	**Average**

General Information

Participant	21
Date of Birth	9/15/15
Chronological Age	5;7
Sex	Female
Test Date	4/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	5%	5	**Poor**
Blending Words	1%	3	**Very Poor**
Sound Matching	16%	7	**Below Average**
Rapid Digit Naming	37%	9	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	2%	69	**Very Poor**
Rapid Naming	45%	98	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	16%	85	**Below Average**
Sounds-in-Sentences	30%	92	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	46%	49	**Average**

General Information

Participant	22
Date of Birth	11/11/16
Chronological Age	4;5
Sex	Female
Test Date	4/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	16%	7	**Below Average**
Blending Words	37%	9	**Average**
Sound Matching	9%	6	**Below Average**
Rapid Color Naming	<1%	2	**Very Poor**
Rapid Object Naming	<1%	2	**Very Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	14%	84	**Below Average**
Rapid Naming	4%	52	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	7%	78	**Borderline**
Sounds-in-Sentences	21%	88	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	8%	36	**Below Average**

General Information

Participant	23
Date of Birth	3/31/15
Chronological Age	6;0
Sex	Male
Test Date	4/15/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	50%	10	**Average**
Blending Words	37%	9	**Average**
Sound Matching	84%	13	**Above Average**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	63%	105	**Average**
Rapid Naming	68%	107	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	88%	118	**Above Average**
Sounds-in-Sentences	87%	117	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	76%	57	**Average**

General Information

Participant	24
Date of Birth	12/27/16
Chronological Age	4;3
Sex	Female
Test Date	4/15/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	84%	13	**Above Average**
Blending Words	84%	13	**Above Average**
Sound Matching	75%	12	**Average**
Rapid Color Naming	16%	7	**Below Average**
Rapid Object Naming	5%	5	**Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	89%	118	**Above Average**
Rapid Naming	5%	76	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	61%	104	**Average**
Sounds-in-Sentences	77%	111	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	73%	56	**Average**

General Information

Participant	25
Date of Birth	9/18/15
Chronological Age	5;7
Sex	Male
Test Date	4/20/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	2%	4	**Poor**
Blending Words	5%	5	**Poor**
Sound Matching	9%	6	**Below Average**
Rapid Digit Naming	1%	3	**Very Poor**
Rapid Letter Naming	<1%	2	**Very Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	2%	69	**Very Poor**
Rapid Naming	<1%	55	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	21%	88	**Average**
Sounds-in-Sentences	39%	96	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	12%	38	**Below Average**

General Information

Participant	26
Date of Birth	2/4/16
Chronological Age	5;2
Sex	Female
Test Date	4/20/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	5%	5	**Poor**
Blending Words	2%	4	**Poor**
Sound Matching	37%	9	**Average**
Rapid Color Naming	9%	6	**Below Average**
Rapid Object Naming	16%	7	**Below Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	5%	75	**Poor**
Rapid Naming	8%	79	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	50%	100	**Average**
Sounds-in-Sentences	58%	103	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	69%	55	**Average**

General Information

Participant	27
Date of Birth	3/21/16
Chronological Age	5;0
Sex	Female
Test Date	4/20/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	5%	5	**Poor**
Blending Words	5%	5	**Poor**
Sound Matching	9%	6	**Below Average**
Rapid Color Naming	<1%	1	**Very Poor**
Rapid Object Naming	16%	7	**Below Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	3%	71	**Poor**
Rapid Naming	1%	64	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	%	96	**Average**
Sounds-in-Sentences	%	105	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	79%	58	**Average**

General Information

Participant	28
Date of Birth	9/29/16
Chronological Age	4;6
Sex	Female
Test Date	4/20/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	16%	7	**Below Average**
Blending Words	9%	6	**Below Average**
Sound Matching	9%	6	**Below Average**
Rapid Color Naming	25%	8	**Average**
Rapid Object Naming	16%	7	**Below Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	6%	77	**Poor**
Rapid Naming	16%	85	**Below Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	34%	94	**Average**
Sounds-in-Sentences	73%	109	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	58%	52	**Average**

General Information

Participant	29
Date of Birth	11/10/16
Chronological Age	4;5
Sex	Male
Test Date	4/20/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	16%	7	**Below Average**
Blending Words	50%	10	**Average**
Sound Matching	50%	10	**Average**
Rapid Color Naming	75%	12	**Average**
Rapid Object Naming	84%	13	**Above Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	35%	94	**Average**
Rapid Naming	84%	116	**Above Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	42%	97	**Average**
Sounds-in-Sentences	58%	103	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	62%	53	**Average**

General Information

Participant	30
Date of Birth	12/11/15
Chronological Age	5;4
Sex	Male
Test Date	4/20/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	5%	5	**Poor**
Blending Words	2%	4	**Poor**
Sound Matching	25%	8	**Average**
Rapid Color Naming	1%	1	**Very Poor**
Rapid Object Naming	<1%	1	**Very Poor**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	3%	73	**Poor**
Rapid Naming	<1%	46	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	58%	103	**Average**
Sounds-in-Sentences	75%	110	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	21%	42	**Average**

General Information

Participant	31
Date of Birth	1/10/17
Chronological Age	4;3
Sex	Female
Test Date	4/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	25%	8	**Average**
Blending Words	16%	7	**Below Average**
Sound Matching	37%	9	**Average**
Rapid Color Naming	16%	7	**Below Average**
Rapid Object Naming	63%	11	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	21%	88	**Below Average**
Rapid Naming	37%	95	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	87%	117	**Above Average**
Sounds-in-Sentences	96%	126	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	86%	61	**Above Average**

General Information

Participant	32
Date of Birth	4/7/16
Chronological Age	5;0
Sex	Female
Test Date	4/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	5%	5	**Poor**
Blending Words	5%	5	**Poor**
Sound Matching	5%	5	**Poor**
Rapid Color Naming	<1%	1	**Very Poor**
Rapid Object Naming	1%	3	**Very Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	2%	69	**Very Poor**
Rapid Naming	<1%	52	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	23%	89	**Average**
Sounds-in-Sentences	53%	101	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	35%	46	**Average**

General Information

Participant	33
Date of Birth	2/18/16
Chronological Age	5;2
Sex	Male
Test Date	4/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	37%	9	**Average**
Blending Words	2%	4	**Poor**
Sound Matching	37%	9	**Average**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	14%	84	**Below Average**
Rapid Naming	53%	101	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	23%	89	**Average**
Sounds-in-Sentences	68%	107	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	46%	49	**Average**

General Information

Participant	34
Date of Birth	3/1/16
Chronological Age	5;1
Sex	Male
Test Date	4/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	50%	10	**Average**
Blending Words	16%	7	**Below Average**
Sound Matching	16%	7	**Below Average**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	21%	88	**Below Average**
Rapid Naming	53%	101	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	45%	98	**Average**
Sounds-in-Sentences	73%	109	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	54%	51	**Average**

General Information

Participant	35
Date of Birth	1/29/16
Chronological Age	5;2
Sex	Male
Test Date	4/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	5%	5	**Poor**
Blending Words	2%	4	**Poor**
Sound Matching	25%	8	**Average**
Rapid Color Naming	9%	6	**Below Average**
Rapid Object Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	3%	73	**Poor**
Rapid Naming	30%	92	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	19%	87	**Average**
Sounds-in-Sentences	53%	101	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	21%	42	**Average**

General Information

Participant	36
Date of Birth	9/25/15
Chronological Age	5;6
Sex	Male
Test Date	4/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	2%	4	**Poor**
Blending Words	1%	3	**Very Poor**
Sound Matching	2%	4	**Poor**
Rapid Color Naming	9%	6	**Below Average**
Rapid Object Naming	50%	10	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	<1%	60	**Very Poor**
Rapid Naming	21%	88	**Below Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	39%	96	**Average**
Sounds-in-Sentences	30%	92	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	58%	52	**Average**

General Information

Participant	37
Date of Birth	9/14/15
Chronological Age	5;7
Sex	Male
Test Date	4/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	2%	4	**Poor**
Blending Words	2%	4	**Poor**
Sound Matching	9%	6	**Below Average**
Rapid Color Naming	<1%	1	**Very Poor**
Rapid Object Naming	<1%	1	**Very Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	1%	67	**Very Poor**
Rapid Naming	<1%	46	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	50%	100	**Average**
Sounds-in-Sentences	53%	101	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	35%	46	**Average**

General Information

Participant	38
Date of Birth	11/17/15
Chronological Age	5;5
Sex	Male
Test Date	4/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	37%	9	**Average**
Blending Words	5%	5	**Poor**
Sound Matching	37%	9	**Average**
Rapid Digit Naming	75%	12	**Average**
Rapid Letter Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	18%	86	**Below Average**
Rapid Naming	75%	110	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	63%	105	**Average**
Sounds-in-Sentences	75%	110	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	89%	62	**Above Average**

General Information

Participant	39
Date of Birth	3/22/15
Chronological Age	6;1
Sex	Female
Test Date	5/17/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	37%	9	**Average**
Blending Words	50%	10	**Average**
Sound Matching	84%	13	**Above Average**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	63%	105	**Average**
Rapid Naming	68%	107	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	73%	109	**Average**
Sounds-in-Sentences	73%	109	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	16%	40	**Below Average**

General Information

Participant	40
Date of Birth	8/16/13
Chronological Age	7;9
Sex	Female
Test Date	5/17/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	16%	7	**Below Average**
Blending Words	16%	7	**Below Average**
Phoneme Isolation	25%	8	**Average**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	37%	9	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	14%	84	**Below Average**
Rapid Naming	45%	98	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	79%	112	**Average**
Sounds-in-Sentences	87%	117	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	66%	54	**Average**

General Information

Participant	41
Date of Birth	8/22/16
Chronological Age	4;8
Sex	Female
Test Date	4/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	9%	6	**Below Average**
Blending Words	9%	6	**Below Average**
Sound Matching	5%	5	**Poor**
Rapid Color Naming	50%	10	**Average**
Rapid Object Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	3%	73	**Poor**
Rapid Naming	61%	104	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	58%	103	**Average**
Sounds-in-Sentences	77%	111	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	58%	52	**Average**

General Information

Participant	42
Date of Birth	3/4/14
Chronological Age	7;2
Sex	Female
Test Date	5/6/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	25%	8	**Average**
Phoneme Isolation	9%	6	**Below Average**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	14%	84	**Below Average**
Rapid Naming	68%	107	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	61%	104	**Average**
Sounds-in-Sentences	79%	112	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	50%	50	**Average**

General Information

Participant	43
Date of Birth	10/24/15
Chronological Age	5;6
Sex	Male
Test Date	5/10/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	2%	4	**Poor**
Blending Words	9%	6	**Below Average**
Sound Matching	1%	3	**Very Poor**
Rapid Color Naming	16%	7	**Below Average**
Rapid Object Naming	2%	4	**Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	1%	65	**Very Poor**
Rapid Naming	3%	73	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	%	79	**Borderline**
Sounds-in-Sentences	%	85	**Below Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	12%	38	**Below Average**

General Information

Participant	44
Date of Birth	12/5/15
Chronological Age	5;5
Sex	Male
Test Date	5/11/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	50%	10	**Average**
Blending Words	25%	8	**Average**
Sound Matching	37%	9	**Average**
Rapid Color Naming	9%	6	**Below Average**
Rapid Object Naming	5%	5	**Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	35%	94	**Average**
Rapid Naming	3%	73	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	27%	91	**Average**
Sounds-in-Sentences	42%	97	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	46%	49	**Average**

General Information

Participant	45
Date of Birth	1/24/15
Chronological Age	6;3
Sex	Male
Test Date	5/11/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	50%	10	**Average**
Blending Words	25%	8	**Average**
Sound Matching	5%	5	**Poor**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	18%	86	**Below Average**
Rapid Naming	53%	101	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	18%	86	**Average**
Sounds-in-Sentences	53%	101	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	18%	41	**Average**

General Information

Participant	46
Date of Birth	5/13/13
Chronological Age	7;11
Sex	Male
Test Date	5/12/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	63%	11	**Average**
Blending Words	25%	8	**Average**
Phoneme Isolation	75%	12	**Average**
Rapid Digit Naming	25%	8	**Average**
Rapid Letter Naming	25%	8	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	58%	103	**Average**
Rapid Naming	21%	88	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	2%	70	**Severe**
Sounds-in-Sentences	21%	88	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	50%	50	**Average**

General Information

Participant	47
Date of Birth	3/7/16
Chronological Age	5;2
Sex	Female
Test Date	5/14/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	50%	10	**Average**
Blending Words	37%	9	**Average**
Sound Matching	25%	8	**Average**
Rapid Digit Naming	25%	8	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	35%	94	**Average**
Rapid Naming	37%	95	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	55%	102	**Average**
Sounds-in-Sentences	63%	105	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	50%	50	**Average**

General Information

Participant	48
Date of Birth	8/16/16
Chronological Age	4;8
Sex	Female
Test Date	5/14/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	63%	11	**Average**
Blending Words	9%	6	**Below Average**
Sound Matching	63%	11	**Average**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	39%	96	**Average**
Rapid Naming	61%	104	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	18%	86	**Average**
Sounds-in-Sentences	30%	92	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	58%	52	**Average**

General Information

Participant	49
Date of Birth	12/29/15
Chronological Age	5;4
Sex	Female
Test Date	5/18/98

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	50%	10	**Average**
Blending Words	50%	10	**Average**
Sound Matching	63%	11	**Average**
Rapid Digit Naming	63%	11	**Average**
Rapid Letter Naming	75%	12	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	58%	103	**Average**
Rapid Naming	75%	110	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	81%	113	**Average**
Sounds-in-Sentences	68%	107	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	54%	5	**Average**

General Information

Participant	50
Date of Birth	12/29/15
Chronological Age	5;4
Sex	Male
Test Date	5/18/98

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	25%	8	**Average**
Blending Words	25%	8	**Average**
Sound Matching	16%	7	**Below Average**
Rapid Color Naming	9%	6	**Below Average**
Rapid Object Naming	16%	7	**Below Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	18%	86	**Below Average**
Rapid Naming	8%	79	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	34%	94	**Average**
Sounds-in-Sentences	30%	92	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	14%	39	**Below Average**

General Information

Participant	51
Date of Birth	7/29/16
Chronological Age	4;9
Sex	Female
Test Date	5/19/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	9%	6	**Below Average**
Blending Words	5%	5	**Poor**
Sound Matching	5%	5	**Poor**
Rapid Color Naming	50%	10	**Average**
Rapid Object Naming	50%	10	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	3%	71	**Poor**
Rapid Naming	53%	101	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	37%	95	**Average**
Sounds-in-Sentences	25%	90	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	54%	51	**Average**

General Information

Participant	52
Date of Birth	1/11/16
Chronological Age	5;4
Sex	Male
Test Date	5/19/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	50%	10	**Average**
Blending Words	25%	8	**Average**
Sound Matching	16%	7	**Below Average**
Rapid Color Naming	37%	9	**Average**
Rapid Object Naming	16%	7	**Below Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	25%	90	**Average**
Rapid Naming	21%	88	**Below Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	1%	67	**Severe**
Sounds-in-Sentences	16%	85	**Below Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	31%	45	**Average**

General Information

Participant	53
Date of Birth	7/22/13
Chronological Age	7;10
Sex	Female
Test Date	5/26/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	16%	7	**Below Average**
Blending Words	37%	9	**Average**
Phoneme Isolation	25%	8	**Average**
Rapid Digit Naming	25%	8	**Average**
Rapid Letter Naming	37%	9	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	21%	88	**Below Average**
Rapid Naming	30%	92	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	75%	110	**Average**
Sounds-in-Sentences	86%	116	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	6%	34	**Below Average**

General Information

Participant	54
Date of Birth	3/10/15
Chronological Age	6;2
Sex	Female
Test Date	3/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	63%	11	**Average**
Blending Words	9%	6	
Sound Matching	63%	11	**Average**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	39%	96	**Average**
Rapid Naming	53%	101	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	82%	114	**Average**
Sounds-in-Sentences	81%	113	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	42%	48	**Average**

General Information

Participant	55
Date of Birth	5/19/17
Chronological Age	4;0
Sex	Female
Test Date	5/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	37%	9	**Average**
Sound Matching	16%	7	**Below Average**
Rapid Color Naming	1%	1	**Very Poor**
Rapid Object Naming	1%	1	**Very Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	21%	88	**Below Average**
Rapid Naming	<1%	46	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	19%	87	**Average**
Sounds-in-Sentences	19%	87	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	14%	39	**Below Average**

General Information

Participant	56
Date of Birth	5/19/17
Chronological Age	4;0
Sex	Female
Test Date	5/27/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	25%	8	**Average**
Sound Matching	37%	9	**Average**
Rapid Color Naming	1%	1	**Very Poor**
Rapid Object Naming	1%	1	**Very Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	25%	90	**Average**
Rapid Naming	<1%	46	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	16%	85	**Below Average**
Sounds-in-Sentences	14%	84	**Below Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	35%	46	**Average**

General Information

Participant	57
Date of Birth	9/27/15
Chronological Age	5;7
Sex	Female
Test Date	5/26/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	50%	10	**Average**
Blending Words	37%	9	**Average**
Sound Matching	50%	10	**Average**
Rapid Color Naming	75%	12	**Average**
Rapid Object Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	45%	98	**Average**
Rapid Naming	68%	107	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	70%	108	**Average**
Sounds-in-Sentences	66%	106	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	58%	52	**Average**

General Information

Participant	58
Date of Birth	5/27/21
Chronological Age	5;0
Sex	Male
Test Date	4/30/16

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	5%	5	**Poor**
Blending Words	5%	5	**Poor**
Sound Matching	63%	11	**Average**
Rapid Color Naming	2%	4	**Poor**
Rapid Object Naming	27%	9	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	12%	82	**Below Average**
Rapid Naming	8%	79	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	4%	73	**Low**
Sounds-in-Sentences	6%	77	**Low**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	27%	44	**Average**

General Information

Participant	59
Date of Birth	6/28/13
Chronological Age	7;11
Sex	Female
Test Date	5/28/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	16%	7	**Below Average**
Blending Words	50%	10	**Average**
Phoneme Isolation	50%	10	**Average**
Rapid Digit Naming	16%	7	**Below Average**
Rapid Letter Naming	9%	6	**Below Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	35%	94	**Average**
Rapid Naming	8%	79	**Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	75%	110	**Average**
Sounds-in-Sentences	86%	116	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	46%	49	**Average**

General Information

Participant	60
Date of Birth	6/30/15
Chronological Age	5;10
Sex	Female
Test Date	5/28/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	50%	10	**Average**
Blending Words	50%	10	**Average**
Sound Matching	50%	10	**Average**
Rapid Color Naming	2%	4	**Poor**
Rapid Object Naming	2%	4	**Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	50%	100	**Average**
Rapid Naming	1%	64	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	86%	116	**Above Average**
Sounds-in-Sentences	82%	114	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	46%	49	**Average**

General Information

Participant	61
Date of Birth	5/4/17
Chronological Age	4;0
Sex	Male
Test Date	5/28/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	63%	11	**Average**
Blending Words	37%	9	**Average**
Sound Matching	25%	8	**Average**
Rapid Color Naming	<1%	1	**Very Poor**
Rapid Object Naming	<1%	1	**Very Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	39%	96	**Average**
Rapid Naming	<1%	46	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	81%	113	**Average**
Sounds-in-Sentences	86%	116	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	38%	47	**Average**

General Information

Participant	62
Date of Birth	2/19/15
Chronological Age	6;3
Sex	Female
Test Date	6/3/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	50%	10	**Average**
Blending Words	37%	9	**Average**
Sound Matching	9%	6	**Below Average**
Rapid Digit Naming	25%	8	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	25%	90	**Average**
Rapid Naming	37%	95	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	34%	94	**Average**
Sounds-in-Sentences	39%	96	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	7%	35	**Below Average**

General Information

Participant	63
Date of Birth	2/1/16
Chronological Age	5;1
Sex	Male
Test Date	3/3/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	37%	9	**Average**
Blending Words	50%	10	**Average**
Sound Matching	25%	8	**Average**
Rapid Color Naming	5%	5	**Poor**
Rapid Object Naming	<1%	2	**Very Poor**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	35%	94	**Average**
Rapid Naming	<1%	61	**Very Poor**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	82%	114	**Average**
Sounds-in-Sentences	77%	111	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	73%	56	**Average**

General Information

Participant	64
Date of Birth	10/27/13
Chronological Age	7;8
Sex	Female
Test Date	7/14/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	9%	6	**Below Average**
Blending Words	16%	7	**Below Average**
Phoneme Isolation	9%	6	**Below Average**
Rapid Digit Naming	25%	8	**Average**
Rapid Letter Naming	25%	8	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	6%	77	**Poor**
Rapid Naming	21%	88	**Below Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	55%	102	**Average**
Sounds-in-Sentences	63%	105	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	14%	39	**Below Average**

General Information

Participant	65
Date of Birth	3/12/14
Chronological Age	7;4
Sex	Female
Test Date	7/14/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	50%	10	**Average**
Phoneme Isolation	16%	7	**Below Average**
Rapid Digit Naming	25%	8	**Average**
Rapid Letter Naming	37%	9	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	25%	90	**Average**
Rapid Naming	30%	92	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	14%	84	**Below Average**
Sounds-in-Sentences	55%	102	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	31%	45	**Average**

General Information

Participant	66
Date of Birth	5/2/15
Chronological Age	6;2
Sex	Female
Test Date	7/13/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	37%	9	**Average**
Sound Matching	37%	9	**Average**
Rapid Digit Naming	50%	10	**Average**
Rapid Letter Naming	50%	10	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	30%	92	**Average**
Rapid Naming	53%	101	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	4%	74	**Low**
Sounds-in-Sentences	14%	84	**Below Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	66%	54	**Average**

General Information

Participant	67
Date of Birth	12/3/14
Chronological Age	6;7
Sex	Male
Test Date	7/16/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	50%	10	**Average**
Blending Words	16%	7	**Below Average**
Sound Matching	50%	10	**Average**
Rapid Digit Naming	75%	12	**Average**
Rapid Letter Naming	63%	11	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	68%	107	**Average**
Rapid Naming	75%	110	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	27%	91	**Average**
Sounds-in-Sentences	58%	103	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	62%	53	**Average**

General Information

Participant	68
Date of Birth	4/15/14
Chronological Age	7;3
Sex	Male
Test Date	7/16/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	9%	6	**Below Average**
Blending Words	9%	6	**Below Average**
Phoneme Isolation	9%	6	**Below Average**
Rapid Digit Naming	37%	9	**Average**
Rapid Letter Naming	25%	8	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	5%	75	**Poor**
Rapid Naming	30%	92	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	23%	89	**Average**
Sounds-in-Sentences	70%	108	**Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	10%	37	**Below Average**

General Information

Participant	69
Date of Birth	11/23/13
Chronological Age	7;7
Sex	Female
Test Date	7/20/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	Percentile Rank	Scaled Score (average range = 8-12)	Descriptive Term
Elision	25%	8	**Average**
Blending Words	25%	8	**Average**
Phoneme Isolation	37%	9	**Average**
Rapid Digit Naming	25%	8	**Average**
Rapid Letter Naming	25%	8	**Average**

Composite Area	Percentile Rank	Composite Score (average range = 90-110)	Descriptive Term
Phonological Awareness	30%	92	**Average**
Rapid Naming	21%	88	**Below Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	Percentile Rank	Composite Score (average range = 86-114)	Descriptive Term
Sounds-in-Words	55%	102	**Average**
Sounds-in-Sentences	88%	118	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	Percentile Rank	Composite Score (average range = 41-59)	Descriptive Term
Motor Proficiency	76%	57	**Average**

General Information

Participant	70
Date of Birth	6/9/14
Chronological Age	7;11
Sex	Female
Test Date	7/22/21

Comprehensive Test of Phonological Processing- Second Edition (CTOPP-2)

Subtest	**Percentile Rank**	**Scaled Score (average range = 8-12)**	**Descriptive Term**
Elision	25%	8	**Average**
Blending Words	75%	12	**Average**
Phoneme Isolation	9%	6	**Below Average**
Rapid Digit Naming	37%	9	**Average**
Rapid Letter Naming	25%	8	**Average**

Composite Area	**Percentile Rank**	**Composite Score (average range = 90-110)**	**Descriptive Term**
Phonological Awareness	30%	92	**Average**
Rapid Naming	30%	92	**Average**

Goldman Fristoe Test of Articulation- Third Edition (GFTA-3)

Subtest	**Percentile Rank**	**Composite Score (average range = 86-114)**	**Descriptive Term**
Sounds-in-Words	79%	112	**Average**
Sounds-in-Sentences	95%	124	**Above Average**

Bruininks-Oseretsky Test of Motor Proficiency- Second Edition (BOT-2)

Short Form	**Percentile Rank**	**Composite Score (average range = 41-59)**	**Descriptive Term**
Motor Proficiency	27%	44	**Average**