An exploration of the occurrence of speech sound disorders in children aged 4;0 – 7;11 years with Autism Spectrum Disorder.

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DECLARATION

I, Stefania Irene Kapoutsis, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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"The roots of education are bitter, but the fruit is sweet" – Aristotle.

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ABSTRACT

Language development in children with autism spectrum disorder (ASD) is an area of study that has received a lot of attention, however there is limited research available on speech development in this population. There is especially limited research that has investigated speech sound disorders (SSDs) in children with ASD in South Africa. This study aimed to describe the type of SSDs children with Autism Spectrum Disorders (ASD) aged 4;0 – 7;11 years present with. The study employed a descriptive, exploratory research design. Twenty-five children aged 4;0 – 7;11 years with a diagnosis of ASD, attending English-medium schools in the Southern Suburbs of Cape Town, South Africa, participated in the study. The findings were described based on the classifications of SSDs (using Dodd's (2005) differential diagnostic framework), intelligibility ratings, production of phonemes and phonotactic structures, the occurrence of phonological processes, oro-motor ability, and prosody. Phonological delays were the most commonly occurring SSDs, this was followed by articulation disorders, phonological disorders and inconsistent phonological disorders. No participants in the sample were diagnosed with childhood apraxia of speech (CAS). The findings suggested that children with ASD appear to acquire vowels, consonants and phonotactic structures at the same trajectory as typically developing children. Variations in the acquisition of fricatives, affricates and liquids were observed. Substitution, syllable and atypical phonological processes were observed across the sample. A higher prevalence of delayed and atypical phonological processes were observed in the sample of children with ASD, compared to the norms available for typically developing children. The results of this study have indicated that while children with ASD acquire phonemes at the same rate as their typically developing peers, children with ASD may be more likely to present with SSDs. These findings highlight the need for SLTs to ensure that accurate speech assessments are carried out among this population, rather than focusing solely on language. This study is a starting point for further research to be carried out on speech development and SSDs in children with ASD.

Keywords: Speech Sound Disorders, Autism Spectrum Disorder, childhood apraxia of speech

GLOSSARY OF TERMS

1. **Alveolar:** A consonant sound that is produced by placing the tip of the tongue onto the alveolar ridge (e.g., /d/ in the word ‘door’ /dɔ/) (Fromkin, Rodman & Hyams, 2013; Roach, 2009).
2. **Affricate:** A consonant sound that begins as a stop and ends off as a fricative (e.g., ‘ch’ /ʧ/ in the word ‘chip'/ʧɪp/) (Roach, 2009).
3. **Diphthongs:** A vowel syllable phoneme that is produced by combining two single vowels (e.g., ‘i’ /ai/ in ‘knife’ /naif/) (Roach, 2009).
4. **Fricative:** A consonant sound that results from a restriction of airflow causing friction (Fromkin et al., 2013; Roach, 209).
5. **Glide:** Consonant sounds that are produced when there is no obstruction to the flow of air (e.g., ‘w’ /w/ in ‘watch’ /wɒʧ/) (Roach, 2009).
6. **Intelligibility:** The proportion of speech output that is easily understood by listeners (Bowen, 2015).
7. **IPA:** The International Phonetic Alphabet serves as a standardised alphabet to transcribe speech sounds (Fromkin et al., 2013).
8. **Labio-dental fricative:** A consonant sound that is produced by the friction created through the obstruction of airflow when the bottom lip makes contact with the upper teeth (e.g., /f, v/ in ‘fan’ /fan/ or ‘van’ /van/) (Fromkin et al., 2013).
9. **Liquid:** Also known as approximants in the literature, liquids are consonant sounds that are produced with little obstruction to the flow of air through the mouth (e.g., ‘r’ /ɹ/ in ‘rain’ /ɹeɪn/) (Roach, 2009).
10. **Nasal:** A consonant sound that is produced by air flowing out the nose rather than out the mouth (e.g., /m/ in ‘moon’ /mʊn/) (Roach, 2009).
11. **Phoneme:** The smallest unit of sound in a language that separates one word from another (Fromkin et al., 2013). For example, ‘cat’ and ‘cats’ where the phoneme /s/ changes the word from singular to plural, and therefore changing its meaning.

12. **Phonology:** The sound system of language which includes rules for how sounds should be combined and pronounced (Fromkin et al., 2013). Phonology can also refer to the study of these sound systems (Fromkin et al., 2013).
13. **Phonological Processes:** Predictable patterns of speech errors in children who are learning to talk (Bowen, 2015). These errors are expected to disappear from the child's speech during standardised age ranges (Bowen, 2015).
14. **Praxis:** The planning and programming of motor movements (Miller, Chukoskie, Zinni, Townsend & Trauner, 2014).
15. **Segment:** Individual units of speech within an utterance (Fromkin et al., 2013; Veenendaal, Groen & Verhoeven, 2016). These may be sounds (phonemes), words or phrases (Fromkin et al., 2013).
16. **Sibilant:** Fricative consonants that are identified as high-frequency hissing sounds such as /s/ in 'sad' /sad/ (Fromkin et al., 2013).
17. **Stop:** A consonant sound that is produced when airflow is completely blocked and then quickly released (e.g., /b/ in 'bed' /bɛd/) (Roach, 2009).
18. **Suprasegmental:** Refers to features of speech that are not pertaining to consonant or vocalic pronunciation but rather prosodic information, such as intonation, stress and rhythm (Veenendaal et al., 2016).
19. **Velar:** A consonant sound that is produced when the back of the tongue raises to make contact with the velum (e.g., /k/ in the word 'cake' /keɪk/) (Fromkin et al., 2013).
20. **Voiceless:** A sound that is produced when there is no obstruction to airflow through the vocal folds (e.g., /p/ in 'pig' /pɪg/) (Fromkin et al., 2013).

CONVENTIONS USED

1. Chronological age is presented in the format 4;6 years (i.e., four years and six months).
2. Phonemic transcriptions (targets) are presented in slanted brackets following the English orthography in quotation marks (e.g., ‘gloves’ /glʌvz/) and phonetic transactions (realisations of the target) are presented in square brackets (e.g, [glʌbz]).
3. Changes in phonemes are presented in bold in the participants’ production (e.g., ‘glo**v**es’ /glʌ**v**z/ produced as [glʌ**b**z]).
4. Arrows in tables are used to show changes from the target word to a participant’s production (e.g., ‘glo**v**es’ /glʌ**v**z/ → [glʌ**b**z]).
5. In Table 3 and Table 4, superscript represents the type of study, with ‘L’ indicating longitudinal design and ‘CS’ a cross-sectional design.

OUTLINE OF DISSERTATION

Chapter 1: Introduction

This chapter provides an outline of speech sound disorders (SSDs) in children with Autism Spectrum Disorder (ASD). Various approaches used to classify SSDs are described. This chapter also identifies the gaps in the literature and the rationale for the study is highlighted.

Chapter 2: Literature review

Literature pertaining to typical phonology and speech acquisition of English, as well as, what is known about SSDs in children with ASD is reviewed and critically analysed in this chapter.

Chapter 3: Methodology

Chapter 3 describes the aims and objectives of the present study. Additionally, a description of the research design, participants and research procedures are presented.

Chapter 4: Results

The findings of the study are presented in this chapter. Participants' speech errors are first classified according to Dodd's (2005) differential diagnostic framework, followed by independent and relational analyses of the data obtained.

Chapter 5: Discussion

In Chapter 5, the findings of the study are interpreted and compared to the findings of previous research studies that have documented speech acquisition and SSDs in typically developing children and those with ASD.

CHAPTER 1: INTRODUCTION

This chapter describes what is currently known about speech sound disorders (SSDs) in children with autism spectrum disorder (ASD) worldwide and within the South African context. Information pertaining to the assessment and classification of SSDs is provided, as this is the focus of the study. The rationale for the selection of the study is highlighted, specifically the need for a deeper understanding of the presence and types of SSDs in children with ASD to improve assessment and management of these in this population.

1. 1 Autism Spectrum Disorder and communication

ASD is a neurodevelopmental disorder which manifests on a scale ranging from mild to severe (Christensen & Muddler, 2020). ASD is diagnosed according to a quadrant of impairments (American Psychiatric Association [APA], 2022). These include impairments in communication (verbal and nonverbal), social interaction, sensory processing as well as repetitive and restrictive behaviours related to speech, movement, objects of interest, routines, and sensory stimuli (APA, 2022). For an ASD diagnosis to be made, the symptoms should be present from early childhood and should impact everyday functioning (APA, 2022).

Communication in children with ASD falls on a spectrum ranging from non-verbal to fully verbal (La Valle, Plesa-Swerer & Tager-Flusberg, 2020). Roughly 30% of individuals diagnosed with ASD remain minimally verbal into adulthood (La Valle et al., 2020). Language delays or the absence of spoken language are often the reasons parents initially seek guidance regarding their child’s development (Luyster et al., 2007). While language development has become a common area of study in ASD research (Luyster et al., 2007), there is currently limited data available on speech development and speech characteristics in this population globally. Limited knowledge and understanding of the speech skills in children with ASD impacts on the decision-making process regarding both assessment and intervention. Further research in this area may assist healthcare and education professionals with referrals to speech and language therapy services, as well as aiding speech-language therapists (SLTs) in selecting appropriate assessment batteries and better understanding the links between speech, language and overall communication in children with ASD when constructing management plans.

1. 2 Speech Sound Disorders in children with ASD

SSD is an umbrella term referring to a difficulty with the production of age-appropriate and intelligible speech (APA, 2013; International Expert Panel on Multilingual Children's Speech, 2012; McLeod & Baker, 2017). SSDs include childhood apraxia of speech (CAS), articulation disorders, phonological delays and disorders, as well as inappropriate prosody, including tone, rhythm, stress and intonation (International Expert Panel on Multilingual Children's Speech, 2012; McLeod & Baker, 2017). SSDs have been shown to negatively impact on a child's everyday functioning and participation (Daniel & McLeod, 2017). Both impaired social interactions and challenges associated with academic success have been observed in children with SSDs (Daniel & McLeod, 2017). The challenges associated with SSDs will be discussed in greater detail later in this chapter (section 1.6). Speech development in children with ASD is an under-represented area of research worldwide (Shriberg et al., 2011). It has been noted that studies evaluating the occurrence and impact of SSDs are centred around neurotypically developing children and, therefore, there is minimal literature available on the neuro-diverse population such as children with ASD.

The development of age-appropriate and competent communication has been linked to a predilection towards speech sounds during infancy (Vouloumanos, Martin & Onishi, 2014). Infants can detect that speech is communicative and intentional without an understanding of the subject matter; and for this reason, they are able to draw-out information from their environment and attain the linguistic and pragmatic knowledge necessary for communication development (Vouloumanos et al., 2014). Before learning to talk, infants are noted to have developed an accurate perception of speech sounds, with a perception of vowels developing between 4 and 6 months of age, and consonants between 10 months and 1;0 years old (Tsuji & Cristia, 2014). It has been observed, however, that infants who go on to be diagnosed with ASD show reduced attention to facial features, specifically in response to people who are speaking (Bradshaw et al., 2020; Lewkowicz & Hansen-Tift, 2012; Shic, Macari & Chawarska, 2014). Attention to speech during infancy predicts a child's ability to develop language later in life (Vouloumanos & Curtin, 2014). A study conducted by Yamashiro, Curtin and Vouloumanos (2020) found that infants with ASD do not show a preference for speech sounds over non-speech sounds, suggesting that this may be a reason why children with ASD are inhibited in their communication development as they get older. This concept can be solidified by research that has reported that early exposure and attention to speech sounds is correlated with later language development and speech sound production in children (Lewkowicz & Hansen-Tift, 2012). Furthermore, research has indicated that children with SSDs present with limited speech perception abilities (Hearnshaw, Baker & Munro, 2018). This suggests that due to limited speech perception skills, children with ASD are at risk of developing SSDs.

1. 3 Assessment of SSDs

A comprehensive assessment and analysis of assessment findings is required for an SSD diagnosis to be made. Assessment allows for SLTs to understand a child's speech error patterns, thus permitting the foundational targets for intervention to be determined. SLTs usually assess and diagnose SSDs through the use of standardised assessment tools (Krueger, 2018). However, the use of reported information from parents and educators, as well as observations of the child's speech and communication in multiple environments, are helpful in determining how their SSD affects their everyday functioning (Krueger, 2018; McLeod, Harrison & McCormack, 2012).

Assessment procedures should evaluate a child's oral motor structures and functions to determine the presence of functional and/or structural factors which may impact a child's ability to produce intelligible speech (Dodd et al., 2009). Additionally, an oro-motor examination (OME) is useful in determining the presence of a motor speech disorder (Van Haaften et al., 2020). Following an OME, a single-word naming task should be administered in order to evaluate a child's production of consonant sounds in all target word positions, as well as vowels (Eisenberg & Hitchcock, 2010). Single-word naming tasks are usually easy and quick to administer and can assist the SLT in determining the presence of articulation errors or phonological processes (Eisenberg & Hitchcock, 2010). Error sounds identified during the single-word naming task should be evaluated for stimulability (Eisenberg & Hitchcock, 2010). Stimulability testing allows the SLT to determine whether the child is able to revise their error and produce the phoneme correctly after being provided with visual and/or verbal cues.

Single-word naming tasks administered in isolation may not provide an exhaustive description of a child's speech skills and difficulties (Skahan, Watson & Lof, 2007). Therefore, in addition to a single-word naming task, picture description tasks or informal conversations are essential in order to gain insight into a child's connected speech (Fabiano-Smith, 2019). Connected speech allows clinicians to evaluate a child's use of prosody and overall intelligibility at a conversational level (Fabiano-Smith, 2019). To supplement the information obtained from a formal speech assessment, it is useful to evaluate a child's overall intelligibility in different contexts and with a variety of communication partners by employing a caregiver-based questionnaire (McLeod, Harrison & McCormack, 2012). This allows for the assessment to be holistic and for the SLT to understand how the child's speech is affecting their everyday interactions and participation (McLeod, Harrison & McCormack, 2012).

In South Africa, formal speech sound assessments are usually not culturally and/or linguistically appropriate as they have been standardised on a monolingual English population from other nations. A large portion of the South African population is multilingual (Pascoe et al., 2010), and although many children may attend schools where the language of learning and teaching (LoLT) is English, most of them may not be exposed to or speak English at home. Pascoe and Norman (2011) noted that SLTs in South Africa often face challenges in assessing and managing children with speech and language difficulties because although there are eleven official languages, the majority of SLTs speak English and/or Afrikaans. In this way, children are often provided with SLT services in their second or third language (Mdlalo, Flack & Joubert, 2016; Pascoe & Norman, 2011). Additionally, the scoring norms used in standardised assessment tools cannot always be applied when assessing children in South Africa, and SLTs run the risk of misinterpreting results and misdiagnosing children (Laing & Kamhi, 2003; Mdlalo et al., 2016). This could lead to children with potential speech and language needs being left without treatment, or to children being seen for therapy even when they do not need it. Additionally, the lack of appropriate norm-referenced assessment tools creates a challenge for SLTs in ensuring that the results they obtain are valid (Pascoe & Norman, 2011). In the past decade research efforts have been made to address these challenges, through trialling existing assessment tools on monolingual children acquiring South African English (SAE), as well as children acquiring SAE in addition to other languages such as isiXhosa and Afrikaans. These efforts have provided South African SLTs with evidence-based modifications when administering assessments and when interpreting results. These modifications are highlighted in the literature review chapter.

In addition to the challenges of assessing SSDs in the South African population, challenges regarding the assessment of children with ASD have been identified. Similar to the evaluation of multilingual children, there are no formal speech sound assessments available that have been standardised on children with ASD (Broome, McCabe, Docking & Doble, 2017). SLTs assessing this population are required to use assessment tools and procedures that have been developed based on norms obtained from typically developing children as an outline of best practice (Broome et al., 2017). Many children with ASD are non-verbal or minimally verbal, which makes it challenging for SLTs to gain an idea of a child's speech skills using formal assessment tools (Kasari, Brady, Lord & Tager-Flusberg, 2013). Additionally, children with ASD are known to present with difficulties related to joint attention and turn-taking, which makes it challenging to engage these children in a speech assessment (Broome et al., 2017; Kasari et al., 2013). In order to help manage these challenges, SLTs are encouraged to use visual schedules, provide children with multiple breaks during the assessment and provide them with motivating rewards after each assessment task (Broome et al., 2017; Kasari et al., 2013). The challenges faced in assessing speech in children with ASD may lead to SSDs being overlooked and left undiagnosed, which would impact the decisions made when deciding on a management plan. Owing to this, it is important for further research evaluating speech in children with ASD to be conducted so that professionals know what to look out for and know of ways that these children can be better assessed and supported.

1. 4 Classification of SSDs

Following assessment, a thorough analysis of a speech sample is required to classify SSDs. Three prominent approaches used to describe SSDs have been identified in the literature. These include the medical, psycholinguistic and descriptive-linguistic approaches. Within each approach, systems have been developed to classify children with a specific SSD. Firstly, the medical approach proposes that SSDs are the result of an underlying medical condition, for example, a cleft lip or cerebral palsy (Baker, Croot, McLeod & Paul, 2001; Waring & Knight, 2013). Since this approach is based on a diagnosed medical condition, it would be expected that it allows for consistent classifications of SSDs across SLTs when a medical diagnosis has been made. However, it has been noted that the origin of SSDs for most children is unknown and, therefore, a noticeable shortcoming of the medical approach is that SSDs with an unknown aetiology are not accounted for and are therefore unable to be described and classified (Baker et al., 2001; Shriberg, Paul & Flipsen, 2009; Waring & Knight, 2013). Thus, the medical approach is limited in its differentiation of SSDs, which impacts on the ability to describe SSDs thoroughly and prepare an intervention plan for SSDs not caused by a medical condition (Waring & Knight, 2013).

Using the overarching principles of the medical approach, Shriberg et al. (2010) developed the Speech Disorders Classification System (SDCS), in order to classify SSDs in children when the aetiology is unknown. The SDCS attempts to establish the relationship between the aetiology and typology of SSDs (Shriberg et al., 2010). According to the SDCS, SSDs can be classified into four subgroups, which include: normal speech acquisition; speech delay; motor speech disorder; and speech errors (Shriberg at el., 2010). The four subgroups of SSDs are then classified further into eight subgroups in order to establish the aetiology and risk factors of each SSD (Shriberg et al., 2010). As per the SDCS, there are three causes for speech delays: genetic factors affecting the child's cognitive-linguistic processes; auditory-perceptual difficulties resulting from otitis media with effusion; and psychosocial involvement (Shriberg et al., 2010). Motor speech disorders are classified as CAS, dysarthria, or of an unspecified cause (Shriberg et al., 2010). Finally, speech errors are classified according to two subgroups, namely errors involving sibilant sounds and errors with rhotic sounds (Shriberg et al., 2010). The SDCS is useful in that it allows for causal factors to be identified and managed appropriately within a team of professionals (Stackhouse & Wells, 1997). However, SSDs of unknown origin are not classified by the SDCS, making the scope of the framework limited (Waring & Knight, 2013). The SDCS is not yet intended for use within the clinical setting and therefore the feasibility of this classification framework in clinical practice has not been established (Broomfield & Dodd, 2004; Waring & Knight, 2013). Additionally, the degree to which SLTs would reach the same classification using the SDCS is not well-established (Broomfield & Dodd, 2004; Waring & Knight, 2013). In this way, the reliability and accuracy of the SDCS in clinical practice comes into question.

The second approach is the psycholinguistic approach, which is centred around the idea that a child's speech difficulties develop from a breakdown at one or multiple points within the speech processing system (Baker et al., 2001; Brosseau-Lapré & Rvachew, 2018; Stackhouse & Wells, 1997; Waring & Knight, 2013). The speech processing model comprises three parts, namely input, lexical representation, and output. This speech processing model demonstrates that the perception of speech sounds leads to the storing of lexical representations, which then results in accurate speech output (Stackhouse & Wells, 1997). The psycholinguistic framework is a classification system that combines the underlining theory of the psycholinguistic approach with clinical practice. It suggests that a breakdown in the speech processing model results in an SSD, and by targeting the level at which the breakdown occurred, speech production will be improved (Stackhouse & Wells, 1997). For example, if a child has difficulty distinguishing between phonemes, the SLT knows to work on auditory discrimination or refer the child for an audiology assessment before targeting the child's production of the phoneme. The speech processing model suggests that the perception of speech sounds (i.e., hearing abilities and auditory discrimination of phonemes) leads to the storing of lexical representations (i.e., the ability to store semantic and phonological features of words accurately) which then results in accurate speech output (i.e., planning speech movements and speech production) (Stackhouse & Wells, 1997; Waring & Knight, 2013). The figure below shows a simplified outline of this model.

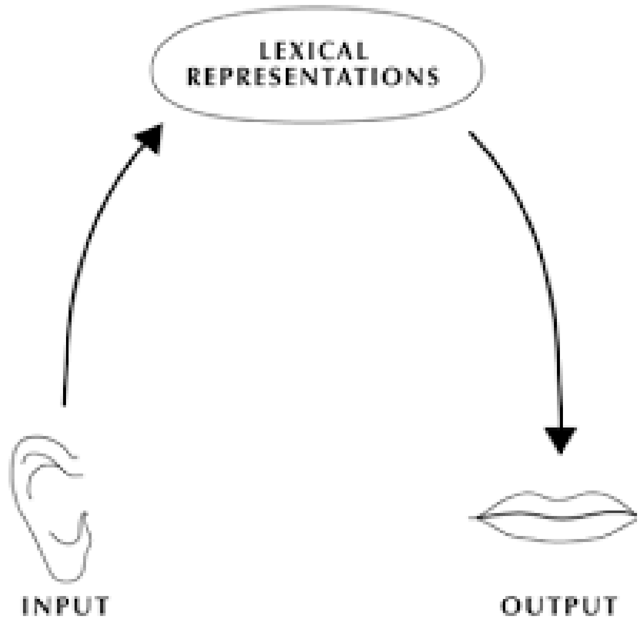

Figure 1. Simplified outline of the speech processing model (Stackhouse & Wells, 1997, p.9)

The psycholinguistic framework is useful as it allows for classification of all SSDs, regardless of whether there is a known cause (Brosseau-Lapré & Rvachew, 2018; Stackhouse & Wells, 1997; Waring & Knight, 2013). Although the psycholinguistic framework has been noted to be a holistic classification system, it has shortcomings in clinical practice (Waring & Knight, 2013). Since the framework considers SSDs to be a result of a breakdown in the speech processing chain, co-morbid conditions are overlooked when classifying SSDs (Waring & Knight, 2013). For example, pre-existing conditions may result in a breakdown in the speech processing chain (e.g., executive functioning difficulties) and thus lead to speech impairments (Waring & Knight, 2013). Furthermore, variations are noted in the diagnoses made by SLTs using this framework, and this causes discrepancies to arise regarding the type of management and predictive success of intervention plans (Broomfield & Dodd, 2004; Waring & Knight, 2013).

The third approach that is widely used to describe and analyse SSDs is the descriptive-linguistic approach. The descriptive-linguistic approach is aimed at describing how a child's speech patterns differ from that of their typically developing peers (Baker et al., 2001; Waring & Knight, 2013). Dodd's (2005) differential diagnostic framework is a classification system that allows for children's speech difficulties to be classified according to a descriptive-linguistic approach. This classification system is noted to be valid, reliable and feasible (Waring & Knight, 2013). The differential diagnostic framework provides suggestions of intervention approaches for each subgroup of SSD, making it particularly useful in a clinical setting (Dodd, 2005; Waring & Knight, 2013). It has been found to be reliable in classifying SSDs in children within the South African context (Mahura, 2021; Pascoe et al., 2018; Rossouw, Pascoe, Smouse, 2016). Additionally, the framework has been used alongside the Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd, Hua, Crosbie, Holm & Ozanne, 2002) assessment tool, which is discussed in depth in Chapter 3, Section 3. This study used Dodd's (2005) differential diagnostic framework to classify the speech of children in this study.

Dodd's (2005) differential diagnostic framework classifies SSDs into five subgroups, namely: articulation disorders, phonological delay, consistent phonological disorder, inconsistent phonological disorder, and CAS. The main features of this framework are presented in table 1 and described below.

Table 1. Main features of the differential diagnostic framework (Dodd, 2005)

SSD	Classification	Suggestions for intervention
Articulation disorder	Consistent substitutions and distortions of specific phonemes.	Traditional articulation therapy
Phonological delay	Phonological processes persist beyond the age of suppression.	Whole language and phonological contrast therapy.
Phonological disorder	Consistent use of non-developmental phonological error patterns.	Phonological contrast therapy.
Inconsistent phonological disorder	Inconsistent errors when producing the same phoneme, syllable, or word. Occur in the absence or oro-motor difficulties.	Core vocabulary therapy.
CAS	Inconsistent speech errors that occur alongside oro-motor difficulties.	Core vocabulary therapy.

Articulation disorders are described as difficulty with the production of specific speech sounds (Dodd, 2005). With articulation disorders, speech sound errors include substitution and distortions which are consistent and occur in all contexts, such as the initial, medial and final word positions (Dodd, 2005). A common illustration of an articulation disorder is the lateral lisp, a distortion of the voiceless alveolar fricative /s/, which is usually produced as 'tlh' /ɬ/ (e.g., '**s**un' /**s**ʌn/ produced as [**ɬ**ʌn]). Traditional articulation therapy is recommended as best practice in managing children who present with an articulation disorder (Dodd, 2005, 2014). Traditional articulation therapy involves targeting one error sound at a time and ensuring a child can (1) discriminate between the target sound and the error sound, (2) produce the sound in isolation, (3) produce the sound in syllables, (4) produce the sound in words, and (5) produce the sound in a sentence (Bessas & Trimmis, 2016).

Phonological delays refer to a pattern of speech errors, in the form of phonological processes that follow a typical developmental course but are immature for the child's age (Dodd, 2005). An example is velar fronting, which refers to substituting velar consonant phonemes /k, ɡ/ with alveolar consonant phonemes /t, d/ such as the production of [**t**ɑ] for the word '**c**ar' /**k**ɑ/ (Bowen, 2011). Dodd (2005, 2014) recommends that whole language and phonological contrast intervention are two best practice intervention approaches when managing a child that presents with a phonological delay.

Thirdly, consistent phonological disorders are attributed to the consistent presentation of non-developmental phonological errors in a child's speech (Dodd, 2005). It is important to note that errors be atypical for the language the child is acquiring, since errors that may be labelled as atypical in one language could be typical in another (Lim, 2018). Atypical phonological errors in English include backing, for example producing '**d**uck' /**d**ʌk/ as [**g**ʌk], and initial consonant deletion, [ʌk] for '**d**uck' /**d**ʌk/ (Dodd, 2014). Phonological contrast therapy is currently the only evidence-based intervention program that is indicated for children with consistent phonological disorders (Dodd, 2014).

In contrast, an inconsistent phonological disorder is indicated when a child presents with different errors when producing the same phoneme, syllable or word (Bowen, 2011; Dodd, 2005). Token-to-token inconsistency should be present in order for speech to be classified as inconsistent (Dodd, 2005). For example, the word 'co**ff**ee' /kɒ**f**i/ as [kɒ**t**i], [**t**ɒ**t**i], [**t**ɒfi] on different productions. Inconsistent phonological disorders occur in the absence of any oro-motor difficulties (Dodd, 2005). It is noted that the most successful intervention program for children with inconsistent phonological disorders is core vocabulary therapy (Dodd, 2014; Dodd, Holm, Crosbie & McIntosh, 2010). Core vocabulary therapy centres around establishing consistency and accuracy on whole words (Dodd, 2014).

Lastly, CAS is a developmental SSD affecting the motor planning and programming of speech (Bowen, 2014; Feldman & Messick, 2008; Sayahi & Jalaie, 2016). CAS is characterised by speech errors that are inconsistent, occurring alongside oro-motor challenges such as groping movements and difficulties sequencing articulatory movements (Dodd, 2005). Three major differential diagnostic criteria for CAS have been proposed (Morgan & Webster, 2018; Tierney et al., 2015). These include: (1) Inconsistent errors of sounds, syllables or words upon repeated productions; (2) lengthened and disrupted co-articulatory transitions often observed as oral groping movements, increased omissions of sounds in words and hypernasality; and (3) inappropriate prosody (Morgan & Webster, 2018; Tierney et al., 2015). CAS may occur in the absence of any coexisting neurodevelopmental disorders – known as isolated idiopathic CAS (Morgan & Webster, 2018). However, CAS more commonly presents alongside a neurodevelopmental disorder and co-occurring SSDs – such as articulation, phonation, childhood dysarthria and/or stuttering (Morgan & Webster, 2018). Furthermore, it has been suggested that CAS may be responsible for limited speech development in children with ASD. This is known as the CAS-ASD hypothesis (Brignell, Dodd, Skyes & Morgan, 2017; Chenausky et al., 2019; Shriberg, Paul, Black & van Santen, 2011).

1. 5 The CAS-ASD hypothesis

The CAS-ASD hypothesis is founded on three rationales, namely motor deficits, genomic factors and phenotypic similarity (Shriberg et al., 2011). The CAS-ASD hypothesis stems from the observation of delayed motor development in children with ASD, which may extend to praxis difficulties in speech (Shriberg et al., 2011). Second, genomic factors were proposed by Poot et al. (2010), who suggested the occurrence of a similar presentation of genes which cause both CAS and ASD. This may be why CAS and ASD both present as cognitive-linguistic impairments (Poot et al., 2010). The third rationale, phenotypic similarity, arose as children with ASD appear to have similar speech, prosody and voice as children with CAS (Shriberg et al., 2011). The results of Shriberg et al.'s (2011) study, however, found no correlation between ASD and CAS. It is suggested that the possible reasons for this may have been due to methodological factors of this study. Nevertheless, the results of the study noted that children with ASD are likely to present with articulatory and phonological speech errors as well as inappropriate prosody and voice. These findings link to the third rationale for the CAS-ASD hypothesis and may be why it is often suggested that CAS is more prevalent in children with ASD. Shriberg et al. (2011) attribute these findings to the "speech attunement framework" rather than to CAS being an underlying cause of speech deficits in children with ASD. The speech attunement framework suggests that children are required to 'tune-in' to their communication partners and 'tune-up' to their own speech attempts (Shriberg et al., 2011). Owing to social communication deficits, children with ASD have difficulty comparing their own speech to that of their communication partners, which may lead to imprecise speech production (Shriberg et al., 2011). Chenausky (2019) found that children with ASD may have speech difficulties related to their diminished ability to monitor and correct their own speech, supporting the theory of the speech attunement framework.

1. 6 Challenges associated with SSDs

While language development in children with ASD has become a well-documented area of research, there is limited data available on the speech acquisition patterns and occurrence of SSDs in this population. Thus, the presence of SSDs in children with ASD may go undetected, and therefore untreated. This is especially true as intervention may prioritise improving language difficulties in these children. Furthermore, there is limited research available on speech development of South African English (SAE), along with the other official languages in the country. While there has been a movement towards establishing speech acquisition norms for various languages spoken in South Africa, these studies have all focused on neurotypical children. There is currently no research available on the speech development patterns or the occurrence of SSDs in children with ASD or other developmental disorders in South Africa. Children with SSDs have been reported to have impaired social interaction, feelings of frustration and limited self-confidence (Daniel & McLeod, 2017). This could lead to social isolation and bullying (Daniel & McLeod, 2017).

In addition, children with SSDs may experience reduced educational success when compared to their peers with age-appropriate speech (Daniel & McLeod, 2017; Loudermill, Greenwell & Brosseau-Lapre, 2021). SSDs have been linked to poor literacy development (Loudermill et al., 2021), a major cause of unsatisfactory educational outcomes in children (Kathard et al., 2011). Distorted production and impairments in the perception of speech sounds are related to difficulties with phonological and morphological awareness, two factors which act as the foundation for later literacy development (Loudermill et al., 2021). The literature has highlighted that children with ASD may have learning difficulties, language delays and/or disorders and impaired social interaction skills (Bhat, 2021; Kjelgaard & Tager-Flusberg, 2001; Knight, Blacher & Eisenhower, 2019). In addition to these difficulties, the presence of SSDs would only add to the challenges faced by children with ASD in education and everyday interactions. Research into SSDs should be treated with the same urgency as language deficits in children with ASD so as not to do these children a disservice in the access to appropriate treatment. With limited literature available, there are no clear guidelines as to the adaptations required when assessing and interpreting speech assessment results or what best practice is in deciding on a treatment approach for this population.

1. 7 Summary

Language development in children with ASD is an area of study that has received considerable attention. However, there is limited research available on speech development in this population. Additionally, the majority of the literature does not include analyses of the speech errors found, making it difficult to interpret whether these children present with typical, delayed or disordered speech patterns. There is especially limited research that has been done into SSDs in children with ASD in South Africa. SSDs may add additional social barriers and obstructions to language and literacy learning in children with ASD. Additional research into the speech characteristics and speech development is required in order for SLTs and other healthcare and education professionals to better assess and manage children with ASD.

CHAPTER 2: LITERATURE REVIEW

The previous chapter introduced the topic of SSDs and theoretical approaches to their classification. The main topic of this thesis – occurrence of SSDs in children with ASD – was also introduced. Gaps within the literature were highlighted, suggesting a need for further research to evaluate the presence of SSDs in children with ASD. This chapter provides a review of typical phonology of English, international variations and South African English (SAE), as well as describe what is currently known about SSDs in children with ASD based on previous research.

2. 1 South African English (SAE)

English is only the sixth most spoken language within households (i.e., home language speakers) in South Africa (Statistics S.A, 2018). However, it has been recorded as the second most widely spoken language outside the home (Statistics S.A., 2018). In this way, the use of English is unique in South Africa and although many may perceive English to be the lingua franca in the country, others have debated that its use stems from history's ideas of power and prestige (Van der Walt & Evans, 2017). Despite this, English does continue to be the prominent language in educational, political, and social settings (Van der Walt & Evans, 2017). Therefore, many South Africans are able to speak English, even if it is not their home language. Within SAE, a number of sub-variations have been noted based on location, ethnicity and the combined languages the individuals speak (e.g., monolingual English speaker versus bilingual Afrikaans and English speaker) (Bekker, 2008; Mesthrie, 1994, 2017). The literature divides SAE into 5 main sub-variants based on ethnicity. These include: 'white' SAE (WSAE); Afrikaans English (AfrE); Cape Flats/Coloured English [1](C[F]E); South African Indian English (SAIE); and, Black SAE (BSAE) (Bekker, 2008, 2012; Mesthrie, 1994, 2017). Phonetic differences distinct to each sub-variant of SAE have been documented. These include features of vowel variations that are distinct to WSAE, such as: (1) The Kin-Pin split, in which the vowel is raised to /ɪ/ in certain words, while it remains /ə/ in all other contexts; (2) backing of the 'bath' vowel, in SAE

[1] In South Africa the term 'coloured' is not a derogatory term. It is used to refer to a culture of people who historically have backgrounds from multiple heritages (Adhikari, 2005).

this vowel is pronounced low and back, /ɑ:/ or /ɒ:/, which contrasts from other global varieties of English in which the pronunciation is generally /a:/ (Bekker, 2012). Furthermore, distinctive features of BSAE which differ from WSAE, include the trill /r/ (pronounced /r/) and an epenthetic schwa (Bekker, 2012). In BSAE, cluster reduction may be noted in adult phonology (Bekker, 2012; Van Rooy, 2004). Within AfrE, it is noted that substitution of voiceless interdental fricative /θ/ for voiceless labiodental fricative /f/ is typical (e.g., 'tee**th**' /ti**θ**/ may be produced as [ti**f**]). Additionally, rhotic /r/ and word final devoicing, such as the substitution of voiced velar /g/ with voiceless velar /k/ in 'do**g**' /dɒ**g**/ (pronounced as [dɒ**k**]) is common in AfrE sub-variants (Bekker, 2012). Features indicated in AfrE and WSAE are also observed in CFE. These include the Kin-Pin split and rhoticisation (Finn et al., 2008). Backing and rounding of the 'goose' vowel, recognised as /u:/ is also common in CFE, as well as SAIE (Finn et al., 2008). While the phonetic differences are typically specific to each sub-variant of SAE, recent literature suggests that these differences between sub-variants are beginning to blur significantly (Mesthrie, 2017). This may be due to changes to economic and social circumstances in modern South Africa (Mesthrie, 2017). It is important for SLTs working in South Africa to be mindful of dialectal variations and to consider that what may be considered a pathology in other English variants may be typical speech in SAE (Pascoe & Mahura, 2017). Table 2 reflects the common variations in SAE that SLTs should be mindful of when interpreting the results of speech sound assessments.

Table 2. Common dialectal variations in SAE (Pascoe et al., 2018)

Dialectal variation	**Example in words**
Alveolar trill /r/ and post-vocalic /ɹ/	‘worst’ /wɜːrst/ ‘writer’ /ɹaɪtəɹ/
Word final devoicing	[dɒ**k**] for ‘do**g**’ /dɒ**g**/
Substitution of /θ/ for /f/ in the word-final position	[ti**f**]for ‘tee**th**’ /ti**θ**/
Reduced contrasts between long and short vowels	‘seat’ /sit/ and ‘sit’ /sɪt/ produced the same
Few central vowels and avoidance of /ə/	‘apple’ /aəpɒl/
Vowel raising. /ɪ/ is used before or after velars, after /h/ and before /ʃ/ in the word-initial position, while /ə/ is used elsewhere.	[j**ɪ**s]for ‘y**e**s’ /j**ɛ**s/
Low and fully back /ɑ:/	‘bath’ /b**ɑ:**θ/

2. 2 Speech acquisition in English

English speech sound acquisition is a well-documented area of research. Most studies use a criterion of 75 – 90% in order to determine the ages of phoneme acquisition (Dodd et al., 2003). Table 3 summarises information obtained from four research studies which have evaluated the speech acquisition in British English, Australian English and SAE.

Table 3. Summary of studies which have evaluated speech sound acquisition in three varieties of English

Author(s)	Participants	Areas investigated	Data collection
Dodd et al. (2003)[CS]	684 British-English speaking children aged 3;0 – 6;11.	Phonetic and phonemic acquisition.	The articulation assessment and phonology assessment subtests of the DEAP (Dodd et al., 2002)
Kilminster & Laird, 1978[CS]	1756 Australian-English speaking children aged 3;0 – 9;0 years.	Phonetic acquisition	Articulation assessment
Pascoe et al. (2018)[CS]	308 SAE speaking children aged 3;0 – 5;11 in Cape Town, South Africa.	Phonetic and phonemic acquisition.	Screening assessment, articulation, phonology, and oro-motor subtests of the DEAP (Dodd et al., 2002)
Mowrer & Burger (1991)	70 isiXhosa and 70 SAE speaking children aged 2;5 – 6;0 years in Cape Town, South Africa.	Phonetic acquisition	41 words were used to assess articulation of consonants in isiXhosa and 20 English words that had shared consonants with isiXhosa were selected to assess articulation in English. Not all English phonemes were assessed.

Age-range (years)	Studies of phonetic and/or phonemic acquisition					
	Dodd et al. (2003)		Kilminster & Laird, 1978	Pascoe et al. (2018)		Mowrer & Burger, 1991
2;0 – 2;11	No data available	Voicing	No data available	No data available	No data available	/p, b, k, g, t, d, m, n, ŋ, w, l/
3;0 – 3;5	/p, b, t, d, k, g, m, n, ŋ, f, v, s, z, h/	Gliding, deaffrication, cluster reduction, fronting, weak syllable deletion, stopping	/p, b, k, g, t, d, m, n, ŋ, h, ʒ, j, w/	/p, b, t, d, k, g, m, n, ŋ, h, w, l, j, f, v, s, z/	Gliding, cluster reduction, deaffrication, fronting, stopping, weak syllable deletion	/f, ʃ, s, j/
3;6 – 3;11	/w, j, l/	Gliding, deaffrication, cluster reduction, fronting, weak syllable deletion	/f/	/ʧ/	Gliding, cluster reduction, deaffrication, fronting, weak syllable deletion	
4;0 – 4;5	/ʧ, ʤ, ʒ/	Gliding, deaffrication, cluster reduction (triclusters)	/ʃ, ʧ, /l/	/ʤ, ʒ/	Gliding, deaffrication	/z, r, ʧ/
4;6 – 4;11		Gliding, deaffrication, cluster reduction (triclusters)	/s, z, ʤ/		Gliding, deaffrication	
5;0 – 5;5	/ʃ/	Gliding	/ɹ/	/ʃ/	Gliding	
5;6 – 5;11		Gliding			Gliding	
6;0 – 6;5	/ɹ/	None	/v/	/ɹ/		
6;6 – 6;11		None				
7;0 – 7;11	/θ, ð/	None				
8;0 – 8;11			/θ, ð/			

The table provides a selective overview of the age ranges of typical speech development. Understanding typical development allows SLTs to recognise when speech may be delayed and when intervention may be required. It is clear from table 3 that English speaking children acquire all stop, nasal and glide consonants earliest between 2;0 – 3;5 years (Dodd et al., 2003; Kilminster & Laird, 1978; Mowrer & Burger, 1991; Pascoe et al., 2018). Dodd et al. (2003) observed glides to develop slightly later, between 3;6 – 3;11 years. This was followed by affricates, with both affricate sounds acquired by 4;11 years (Dodd et al., 2003; Kilminster & Laird, 1978; Pascoe et al., 2018). Liquids are developed next, with palatal liquid /ɹ/ having been developed significantly later, between 5;0 and 6;11, than alveolar liquid /l/ which was observed to be developed by 4;5 years across all four studies (Dodd et al., 2003; Kilminster & Laird, 1978; Mowrer & Burger, 1991; Pascoe et al., 2018). In the study conducted by Mowrer and Burger (1991), alveolar liquid /l/ was noted to be acquired as early as 2;11 years. A complete set of fricative sounds is developed latest. Interdental fricatives /θ, ð/ were noted to be developed after 7;0 years old, making them the last phonemes acquired (Dodd et al., 2003; Kilminster & Laird, 1978; Pascoe et al., 2018).

As can be seen in the table, although data on speech acquisition may vary across different studies, it appears that speech acquisition in different varieties of English (i.e., British English, Australian English and SAE) occurs at similar rates. Noticeable variations in the acquisition of the voiced labiodental fricative (more than six months difference) have been observed across the studies. Dodd et al. (2003) and Pascoe et al. (2018) noted that the voiced labiodental fricative /v/ is acquired between 3;0 and 3;5 years, while Kilminster and Laird (1978) found it to develop much later, between 6;0 and 6;5 years. In addition to consonants, studies indicated that monolingual English-speaking children master all vowel sounds by 3;0 years, and possibly earlier (Dodd et al., 2003; Pascoe et al., 2018).

As well as commenting on the age at which phonemes are acquired, it is important for researchers to determine what phonological processes are typical within each age band. This allows for SLTs to better classify whether a child has age-appropriate speech or an SSD, and what type of SSD. Most phonological processes are seen between 3;0 and 3;11 years, and include gliding, cluster reduction, deaffrication, fronting, stopping, and weak syllable deletion

(Dodd et al., 2003; Pascoe et al., 2018). By age 6;0 years, monolingual English-speaking children no longer present with phonological processes (Dodd et al., 2003; Pascoe et al., 2018). Of note, phonological processes across British English and SAE were observed to be eliminated from a child's speech at the same age (Dodd et al., 2003; Pascoe et al., 2018). This suggests that phonemic development may be the same across the two variants of English.

In addition to phoneme acquisition and the presentation of phonological processes, the research suggests that the occurrence of SSDs in SAE and other English dialects are also similar. A study conducted by Pascoe et al. (2018) indicated that the most commonly occurring SSD subtype in children acquiring SAE was a speech delay (75% of children diagnosed with an SSD). This correlates with data obtained from children acquiring British English (Broomfield & Dodd, 2004). Following phonological delays, the most commonly occurring SSDs in children acquiring SAE and children acquiring British English are articulation disorders, phonological disorders, inconsistent phonological disorders, and finally, CAS (Dodd 2014, Pascoe et al., 2018). Pascoe et al. (2018) estimated that the prevalence rate of SSDs is 9.09% for children between 3;0 – 5;11 years acquiring SAE.

2. 3 SSDs in children with ASD

Research evaluating the presence of SSDs in children with ASD has produced variable results. Some research suggests that speech is a relative strength in children with ASD when compared to their language skills (Kjelgaard & Tager-Fluseberg, 2001). However, there is little research evidence available to support this hypothesis. On the other hand, other research studies have indicated that the majority of children with ASD present with an SSD of some kind (Cleland et al., 2010; Rapin, Dunn, Allen, Stevens & Fein, 2009; Shriberg et al., 2011). The variability of these hypotheses makes it clear that there is no consensus when it comes to this topic and that further research is necessary. In order to review the literature, a search of PubMed, Ebscohost, Scopus and Web of Science databases was conducted using the following free text search terms: 'speech sound disorders in children with autism spectrum disorders', 'speech acquisition in children with autism spectrum disorders', 'articulation disorders in children with autism spectrum disorder', 'phonological disorders in children with autism spectrum disorder', 'phonological processes in children with autism spectrum disorder', 'childhood apraxia of speech in children with autism spectrum', 'speech sound disorder in children with autism spectrum disorder in South Africa'. The search was filtered to articles written in English and published within the last 15 years (i.e., from 2007). The search yielded a relatively small body of literature available on the topic. Table 4 presents the methodology and results of the available literature on SSDs in children with ASD.

Table 4. Summary of studies evaluating SSDs in children with ASD

Authors	Participants	Areas investigated	Data collection	Findings
Rapin et al. (2009)[L]	62 children with ASD between 7;0 – 9;0 years old.	Subtypes of language disorders in ASD, focusing on expressive phonology and comprehension.	Standardised articulation language assessment.	24% of participants presented with impaired speech. A correlation between the presentation of SSDs and reduced language ability was noted.
Cleland et al. (2010)[CS]	69 children with ASD with a mean age of 9;5 years.	Occurrence of speech errors in children with ASD.	Standardised speech assessment.	41% of participants presented with speech errors. Phonological delays were the most commonly occurring SSD.
Shriberg et al. (2011)[CS]	46 children with ASD between 4;0 – 7;0 years.	To assess the CAS-ASD hypothesis and to evaluate the presence of other SSDs in verbal children with ASD.	Continuous speech samples.	No correlation between CAS and ASD. However, results indicated increased prevalence of SSDs in children with ASD. Speech delays were observed in 15.2% of participants and speech errors in 31.8%.
Kjellmer et al. (2018)[L]	83 children ASD between 4;0 – 6;0 years.	To evaluate language (receptive and expressive) and phonology in children with ASD.	A phonological speech production assessment and connected speech tasks.	Phonological speech errors were observed in 21% of the participants in the sample.
Chenausky et al. (2019)[CS]	54 individuals with ASD between the ages of 4;4 – 18;10.	The occurrence and effect of motor speech disorders on expressive language in children with ASD.	Standardised speech and language assessments.	24% of participants presented with suspected CAS. It was noted that both speech production and receptive language impact and determine expressive language abilities.

Table summarises 5 research studies conducted on children with ASD, with a focus on their speech skills. Not all 5 studies were focused solely on speech errors or speech development in this population, further highlighting how limited research is in this area. Of the 5 studies that met the search criteria, 4 were conducted on children acquiring English (3 in the United Stated of America and 1 in Ireland). Kjellmer et al.'s (2018) study was conducted in Sweden on Swedish-speaking children. The studies were conducted on between 62 and 83 participants. Studies conducted by Chenausky et al. (2019), Kjellmer et al., (2018) and Rapin et al. (2009) evaluated both language and speech, and therefore, data collection consisted of both language and speech assessments. Cleland et al.'s (2010) and Shriberg et al.'s (2011) studies consisted of only speech assessments. An in-depth discussion of each of the study findings are presented below.

Cleland et al. (2010) conducted a study of 69 children with ASD. The mean age of the children who formed part of the study sample was 9;5 years. The results of the study indicate that 12% of participants obtained scores reflective of an SSD (Cleland et al., 2010). However, 41% of participants presented with a "small number of errors in their speech" (Cleland et al., 2010, p. 7). These authors suggest that although the errors were classified as "small", they were prominent enough to be significant and would make the children's speech distinctly different from those not presenting with any errors. Most children noted to have an SSD in this study presented with typical phonological and articulation errors which aligned with features of delayed speech (Cleland et al., 2010). These results correlate with the literature on neurotypical children (Dodd, 2014). This suggests that the most commonly occurring SSDs in typically developing children may be the same as those expected in children with ASD. In addition, the study yielded results of atypical speech errors, for example two of the 69 participants presented with phoneme-specific nasal emission in the absence of velopharyngeal insufficiency – an irregular speech pattern which occurs as a result of atypical learning (Cleland et al., 2010). The results of the study indicated no correlation between age and frequency or type of speech error. From this, it may be suggested that non-developmental and immature speech patterns persist in children with ASD beyond the ages noted for typically developing children (Cleland et al., 2010). Interestingly, it was recorded that although these errors were atypical and inappropriate, the children still obtained scores within the normal range of the speech assessment. This was due to the ways in which results are scored with the assessment tool used, namely, the Goldman-Fristoe Test of Articulation-2nd edition (GFTA-2) (Goldman & Fristoe, 2000). The GFTA-2 produces scores within the average range if errors are produced consistently in all word positions. Therefore, children who present with consistent errors would achieve scores within the normal range even if they presented with atypical or immature speech errors (Cleland et al., 2010). Owing to this, fewer children may have been reported as having an SSD than if a different assessment tool and/or method of analysis had been employed.

A research study which investigated the language (receptive and expressive) abilities and phonology in children with ASD yielded results indicating that 21% of the study sample presented with errors in phonology (Kjellmer, Fernel, Gillberg & Norrelgen, 2018). The study was conducted on eighty-three children between the ages of 4;0 and 6;0 with a diagnosis of ASD. Errors in phonology were described as the presence of non-developmental or unusual phonological processes in a participant's speech (Kjellmer et al., 2018). These errors would be classified as either phonological delays or phonological disorders if Dodd's (2005) diagnostic framework had been used. While the study highlighted the presence of phonological speech errors in children with ASD, it did not specify whether these errors were atypical or delayed. This information could have been helpful in understanding whether children with ASD are likely to present with similar phonological error patterns as their typically developing peers or whether error patterns in children with ASD are more likely to be non-developmental.

Similarly, a study conducted by Rapin et al. (2009) yielded results which indicated the occurrence of SSDs in children with ASD. The study included 62 children with ASD aged 7;0 – 9;0 years. The study found that 24% (*n*= 15) of participants presented with an impairment in expressive phonology. It was not indicated what type of SSD these participants presented with. The remaining 76% (*n= 47*) had borderline or above average speech output, which Rapin et al. (2009) suggested is indicative that by school-age most children with ASD no longer present with speech difficulties. This suggests that children with ASD may present with similar speech development patterns as their typically developing peers. Rapin et al. (2009) used an articulation assessment to evaluate the speech characteristics in children with ASD. By only using an articulation assessment, the results may have missed children with phonological speech errors and/or inconsistent speech. This could explain the difference in the results obtained by Rapin et al. (2009), that most children with ASD present with age-appropriate speech by school-going age, and other similar studies which have indicated that children with ASD seem to have persisting speech errors (Chenausky et al., 2019; Cleland et al., 2010). Impaired phonology appeared to be correlated with both receptive and expressive language difficulties, in this way, impaired speech production presented alongside below average language abilities. This is logical, as difficulty differentiating between sounds that may change the meaning of words could impact on understanding as both a speaker and a listener. Other studies have supported these findings and have suggested a comorbidity between SSDs and language disorders (Chenausky et al., 2019; Lewis, Freebairn, Hansen, Iyengar & Taylor, 2004).

Results of a study conducted by Lewis et al. (2004) indicated correlations between motor speech disorders, specifically CAS, and language disorders. The study evaluated changes in the speech skills of 39 typically developing children from pre-school through to school age. To be included in the study, participants needed to have been diagnosed with CAS or another type of SSD. Lewis et al. (2004) observed that while improvements in intelligibility were observed from pre-school to school age for all participants in both speech and language, participants with CAS showed reduced improvement in language when compared to participants with other SSDs. This suggests a relationship between language development and CAS. These findings were supported by the results of a study conducted by Chenausky et al. (2019), which aimed to investigate the presence of motor speech disorders and their effect on expressive language development in minimally verbal individuals with ASD. Fifty-four participants aged 4;4 – 18;10 years formed part of their study sample (Chenausky et al., 2019). Chenausky et al. (2019) assessed the participants' receptive and expressive language skills and speech. Their results indicated that 13 participants (24%) presented with suspected CAS. Consonant distortions, vowel errors and hypernasality were the three most common speech difficulties noted among the participants who were suspected to have CAS. In their analysis, Chenausky et al. (2019) noted that receptive language and speech appeared to be concurrent influencers of expressive language ability in individuals with ASD. The idea that motor speech disorders are responsible for reduced language output in children with ASD gave rise to Shriberg et al.'s (2011) CAS-ASD hypothesis.

As highlighted in Chapter 1 Section 5, Shriberg et al.'s (2011) CAS-ASD hypothesis suggests that CAS may be the underlying cause for reduced language abilities in children with ASD. SSDs in Shriberg et al.'s (2011) study were classified according to the SDCS framework (Shriberg, 2010). The results indicated that 15.2% of participants presented with speech delays and 31.8% with speech errors. However, none of the participants in the sample were recorded as having presented with CAS. It has been suggested that this may be due to methodological factors. One of the inclusion criteria for the study was that participants were required to have a 70% intelligibility rating, which may have impacted the types of speech errors and the prevalence of CAS in the sample (Shriberg et al., 2011). CAS is known to impact significantly on a child's intelligibility, therefore participants with lower levels of intelligibility may have been more likely to present with CAS. Furthermore, not all the diagnostic markers for CAS were assessed in this study (Shriberg et al., 2011). Again, affecting the likelihood that participants would present with CAS. These limitations highlight the need for further research in investigating SSDs and occurrence of CAS in children with ASD. Furthermore, bilingual children were excluded from the study and may have limited the diversity of the sample, therefore impacting how the data could be generalised to a variety of populations.

A review of the literature has indicated that there is limited information available on the speech development and SSDs in children with ASD. Additionally, as observed in the literature review, studies that have been conducted have focused on mainly monolingual English-speaking children in the Western world. More research is required in order to add to the limited set of knowledge we currently have on this topic. Furthermore, more diverse research is required, focusing on a range of languages, children in a greater variety of settings, and children acquiring two or more languages.

2. 4 Summary

This chapter provided an overview of the available literature on the occurrence of SSDs in children with ASD. Additionally, a review into the speech sound development of British English and SAE was provided. A review of previous research indicates that SSDs commonly occur in children with ASD. However, there is limited research available and further research globally and within the South African context is required. The following chapter will discuss the aims and objectives and the methods used in the present study in evaluating the occurrence of SSDs in children with ASD.

CHAPTER 3: METHODOLOGY

This chapter describes the aims and objectives of the study. The research design, recruitment process and the research procedure, alongside rationale for the decisions made throughout the research process are also explained. Finally, ways in which the reliability, validity and ethical standards were maintained throughout the study are addressed in this chapter.

3.1 Aims

This study aimed to describe the types of speech sound disorders (SSDs) children with Autism Spectrum Disorders (ASD) aged 4;0 – 7;11 years present with.

3.2 Objectives

1. To describe the types and severity of SSDs that children with ASD aged 4;0 – 7;11 years present with.

3.3 Research design

A descriptive, exploratory research design was employed to investigate the types of SSDs children with ASD aged 4;0 – 7;11 years present with. Both descriptive and exploratory research allow for participants to influence the researcher's understanding of a phenomenon that has not been extensively studied (Hammarberg, Kirkman & de Lacy, 2019; Hunter, McCakkum & Howes, 2019). In the current study, the phenomenon studied is SSDs in children with ASD. This phenomenon is an under-researched area in South Africa and globally. Therefore, this research design allowed the researcher to observe the speech of children with ASD and describe them in detail in order to identify the presence of SSDs. Descriptive exploratory research may lead to tentative findings (Stebbins, 2001). While research findings may be inconclusive, this research design permits for an in-depth discussion of SSDs in children with ASD, which allows for a better understanding of the phenomenon and lays a foundation for similar studies to be conducted in the future (Stebbins, 2001). Additionally, both descriptive and exploratory research designs have been employed in previous research studies evaluating speech development and/or SSDs in children (Mahura, 2014; Maphalala, 2012; Shriberg et al., 2011).

3.4 Participants

The participant group consisted of 25 children aged 4;0 – 7;11 years, with a formal diagnosis of ASD. A sample size of 25 participants was selected based on other related studies which have described the speech skills of school aged children (Mahura & Pascoe, 2016; Maphalala, Pascoe & Smouse, 2014; Pascoe & Jeggo, 2019). Participants were enrolled in schools across the Southern and Northern Suburbs of Cape Town, South Africa. The age range of 4;0 to 7;11 years was selected as the literature suggests that SLTs receive the highest number of referrals for typically developing children between the ages of 3;0 and 6;0 years (Broomfield & Dodd, 2004; Camilleri & Law, 2007; Morgan et al., 2017). The age range of 3;0–6;0 years was extended to 4;0–7;11 years for the current study as children with ASD often present with co-occurring developmental delays, and due to this may only develop speech later than their typically developing peers (Camarata, 2014; Erasmus, Kritzinger & van der Linde, 2021; Volkmar et al., 2004). Additionally, this age range was selected as it has been recorded that the average age during which a child receives a formal diagnosis of ASD and is enrolled at an ASD-specific school in South Africa is between 5;0 and 9;0 years (Erasmus et al., 2021).

3.4.1 Selection criteria

There were twenty-two boys and three girls included in the study. Participants were not stratified based on gender and the unequal distribution of boys to girls was expected prior to the start of participant recruitment and data collection, as ASD is known to be more commonly diagnosed in males (Hull, Petrides & Mandy, 2020; Volkmar et al., 2004). Participants had to be acquiring South African English and attending schools where the language of learning and teaching (LoLT) is English. English is the lingua franca in South Africa and is often introduced as an additional language in schools from the third year of schooling. However, due to the linguistic diversity in South Africa, participants were not required to be home language English speakers. This allowed for the research to be more inclusive. Participants were required to present with adequate language abilities to be included in the study. The following criteria were used in determining whether children had adequate language abilities: a) able to understand one-step instructions consistently (e.g., 'Tell me what you see' and 'stick out your tongue'); b) able to understand and respond to 'wh' questions (e.g., 'who, what and where') appropriately; c) able to identify and label pictures independently (e.g., 'pig', 'door', 'spider' etc.); and d) able to use 3–5-word utterances during conversational speech and when describing a picture. Some children do well in speech tasks with repetition and, in this way, having children repeat after the researcher may not have provided an accurate representation of their spontaneous speech skills (McLeod & Masso, 2019). Therefore, it was necessary in conducting the speech assessment that participants had adequate vocabulary to label most pictures spontaneously. Case history information obtained from participants' parents and/or legal guardians and teachers was used alongside screening to determine whether learners met the criteria used to determine their language abilities. Owing to the nature of the speech assessment, children who were unable to recognise or label pictures because of visual difficulties or limited spoken language skills were not included in the study. Additionally, the decision to exclude certain children from the research study was made due to time and budget constraints, given that this study was part of a master's project.

3.5 Methods of recruitment

Firstly, permission to conduct the research study was obtained from the University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee (HREC) (REF: 572/2021 – Appendix A). Permission was then obtained from the Western Cape Department of Basic Education (DBE) (REF: 20211022-6952) (Appendix B) to conduct the research study in schools in the Western Cape. The heads of seven schools which were identified for data collection were then sent a letter requesting permission to conduct research at their schools (Appendix C). Educators at each school were provided with a detailed description of the purpose of the study and their roles in the research process (Appendix D). The educators assisted the researcher in identifying children who met the study criteria. Information letters (Appendix E), consent forms (Appendix F), case history forms (Appendix H) and the Intelligibility in Context Scale (ICS) (McLeod et al., 2012) (Appendix I) were sent to the parents and/or legal guardians of the children who had been identified as potential participants. Once written consent had been obtained from parents and/or legal guardians, the educators completed a questionnaire with case history information and questions regarding the children's behaviour and learning at school (Appendix J). Lastly, participants were given information on the research study in a child-friendly manner using visual aids. The participants were given the opportunity to provide verbal assent (Appendix G). They were all able to provide assent, either verbally or by pointing to a picture card reflecting 'yes'. The flow-chart below outlines the methods of recruitment.

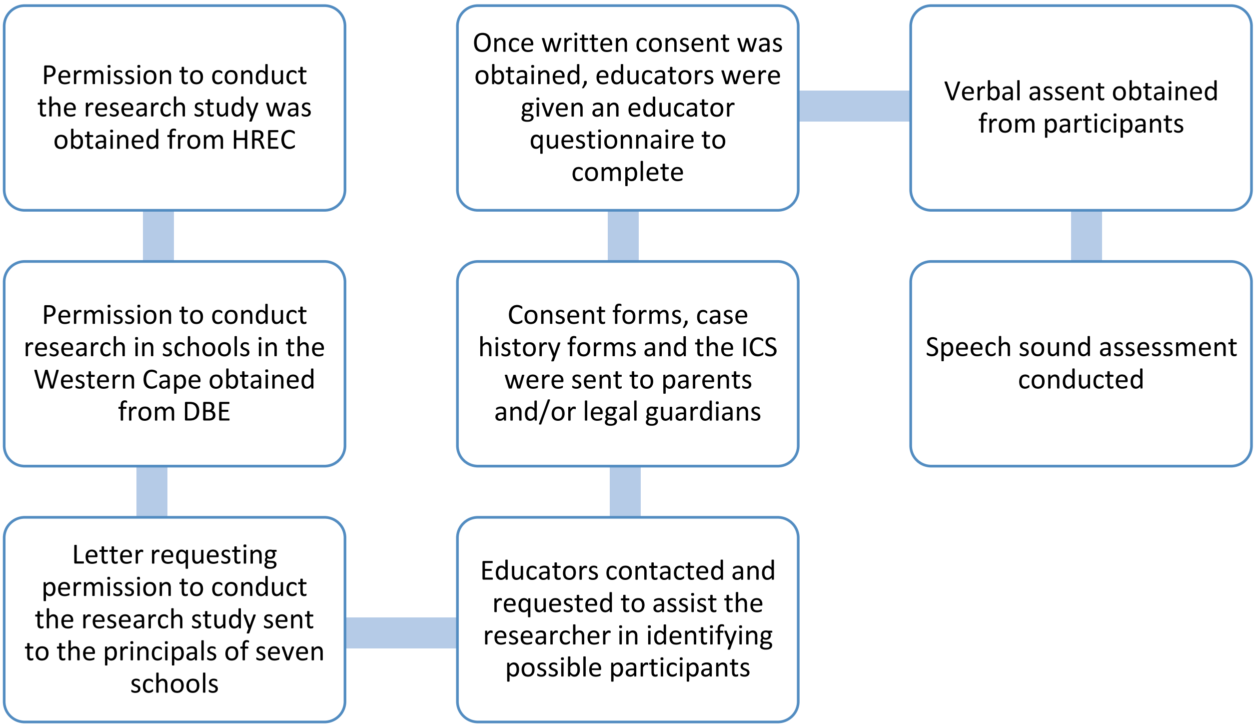

Figure 2. Flow chart indicating the methods of recruitment

3. 5.1 Sampling method

A convenience sampling method was used to select participants. Convenience sampling is a non-probability sampling procedure, which allowed for participants to be selected based on their availability and willingness to participate (Etikan, Musa & Alkassim, 2016; Stratton, 2021). Participants were considered as available and willing to participate when their parents and/or legal guardians had provided informed consent and the children themselves had provided assent. Convenience sampling is a popular sampling method as it is simplistic, and cost and time efficient (Etikan et al., 2016; Stratton, 2021). This was helpful for the present study as it was part of a master's project, which presented time and budgetary constraints. It is noted that this sampling method may have limited randomisation of participants, as well as, resulted in reduced participation rates (Etikan et al., 2016; Stratton, 2021). The research study compensated for these limitations by having a detailed outline of the recruitment plan and by recruiting as many participants as possible, as suggested by Stratton (2021).

Consent forms and information letters were sent out to 50 children who met the study criteria across the seven schools identified. Thirty-seven consent forms were returned by the learners' parents and/or legal guardians. Four learners were then excluded from the study because they were younger than 4;0 or older than 7;11 years. Upon conducting the speech assessments, a further five learners were excluded. These learners were unable to follow one-step instructions consistently or spontaneously label most of the picture cards presented to them. From the remaining 28 children, three were selected at random to participate in the pre-pilot study. Therefore, the final study sample size was 25, as shown in the graph below.

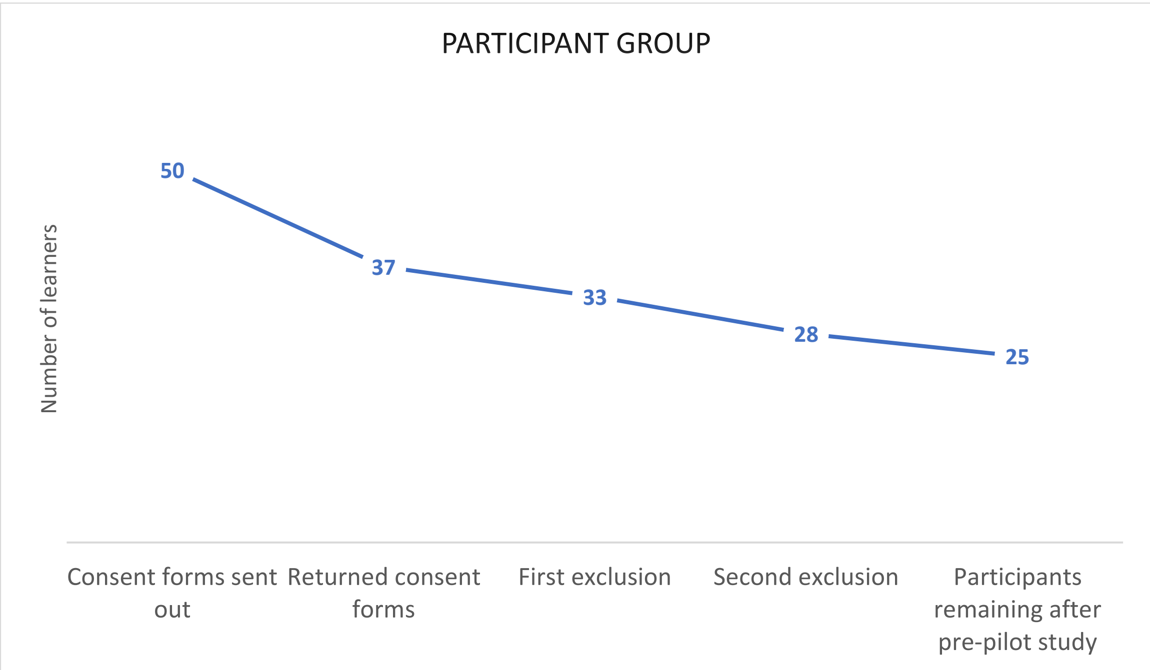

Figure 3. Procedure of sample selection

3.6 Description of materials

Parents and/or legal guardians were given a case history form and the ICS (McLeod et al., 2012) to complete (Appendix I), and the educators were asked to complete a separate questionnaire (Appendix J). The case history form and the educator questionnaire were constructed by the researcher as standardised case history forms are currently not available (Fulcher-Rood, Castilla-Earls & Higginbotham, 2019). The case history form aimed to gain insight into the participants' developmental history and current level of functioning, while the educator questionnaire was used to obtain information pertaining to participants' behaviour and participation in the classroom. The case history form and educator questionnaire were adapted from the literature (Shipley & McAfee, 2009) and based on forms that were employed in studies of a similar nature (Maphalala, 2012). The ICS is a questionnaire designed for communication partners and consists of seven questions, which are answered on a 5-point Likert scale with answers ranging from "never" (0) to "always" (5) (McLeod et al., 2012). It was used to get an understanding of the children's speech intelligibility in a variety of contexts (e.g., at home and at school) and with various communication partners (e.g., parents and/or legal guardians, extended family members, other children, teachers, and strangers) (McLeod et al., 2012). The ICS has been previously trialled in clinical practice in South Africa and preliminary findings have shown it to be useful in obtaining data on a child's speech intelligibility within this context (Pascoe & McLeod, 2016).

The Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd et al., 2002) was used to evaluate the speech of the participants. The DEAP is a formal speech sound assessment that was developed to determine a differential diagnosis of SSDs in children aged 3;0 – 8;11 years. Although the DEAP was not standardised on the South African population, it is commonly used by South African SLTs and has been noted to produce reliable results in clinical practice (Pascoe et al., 2018). The DEAP was adapted to make the assessment appropriate for monolingual and bi/multilingual children acquiring South African English. The following adaptations were highlighted by Pascoe et al. (2018): a) voiceless interdental fricative /θ/ may be produced as labiodental fricative /f/ in the word-final position by children acquiring Afrikaans; b) the production of the alveolar trill /r/ and postvocalic /ɹ/ are acceptable across different sub-varieties of South African English (e.g., it is common for

Afrikaans and isiXhosa speaking individuals to use the alveolar trill /r/ in place of the postvocalic /ɹ/ more frequently); c) vowels may be produced differently depending on the variety; and d) word final devoicing is typical in other dialects of South African English. Further common dialectal variations in South African English, as indicated by Pascoe and Mahura (2017) and Pascoe et al. (2018), have been noted in Chapter 2 (section 2.1). Additionally, the screener subtest of the DEAP was not administered as it was not necessary for the purposes of this research study. This is because all subtests were administered with all participants in order to allow for a thorough analysis of all areas of speech, even if a participant's speech was deemed to be age-appropriate.

The following three subtests of the DEAP were conducted with each participant:

(1) Articulation and Oro-motor assessment

The oro-motor assessment was useful in determining whether any structural and/or functional factors were influencing the participants' speech (Dodd et al., 2009). This involved having each participant produce isolated oro-motor movements (e.g., tongue protrusion) and sequenced movements (e.g., kiss and blow). This was done in order to note the symmetry of movements and the co-ordination and fast-acting movements of the articulators (Dodd et al., 2009). Part of the OME included an assessment of diadochokinetic (DDK) rates. DDK rates refer to one's ability to sequence speech sounds accurately and at a rapid pace, which is useful in establishing a differential diagnosis of CAS (Van Haaften et al., 2020). The articulation assessment required participants to label picture cards presented to them. This allowed for the researcher to determine whether the child was able to correctly produce vowels and consonant sounds of the English speech sound system (Dodd et al., 2009). Secondly, participants were given the opportunity to imitate speech sounds that were incorrectly produced in the picture-naming task – this was useful in determining whether they were stimulable for correct production of certain phonemes (Dodd et al., 2009).

(2) Phonology assessment

The phonology assessment involved a picture-naming task and a connected speech task (Dodd et al., 2009). The phonology assessment was used to identify the presence of phonological errors (Dodd et al., 2009). This assisted the researcher in classifying each participant's speech as age-appropriate, delayed or atypical.

<u>(3) Word inconsistency assessment</u>

This subtest required participants to produce each target word three times in succession. This allowed for the researcher to determine whether participants presented with any inconsistencies in their speech. Determining the frequency of inconsistent errors in a child's speech is useful in establishing a differential diagnosis of CAS or an inconsistent phonological disorder (Dodd, 2005).

3.7 Pre-pilot study

Three participants out of the 28 who met the selection criteria and whose parents and/or legal guardians provided informed consent, were randomly selected for the pre-pilot study. These three participants (aged 5;4, 6;6, and 7;6 years) were assessed using the DEAP (Dodd et al., 2002). The pre-pilot study allowed the researcher to determine how well participants understood instructions, whether enough time had been allocated per assessment, and to establish what cues were required during the assessments to elicit speech production. In this way, the pre-pilot study increased the validity and reliability of the research procedure and findings. The pre-pilot study helped the researcher determine ways in which target words in the DEAP could be cued. For example, all three participants included in the pre-pilot study did not produce the targets 'van' /van/ and 'ladybird' /leɪdibɜd/ when shown the matching picture cards. Differences between words used in South African English and the target words in the DEAP were noted. Participants said 'truck' /tɹʌk/ or 'taxi' /taksi/ when shown the picture card for a 'van' /van/. This compliments the findings reported in the study conducted by Pascoe et al. (2018). The word 'van' /van/ had to be modelled for all participants. Additionally, all three participants said 'ladybug' /leɪdibʌg/ instead of the target 'ladybird' /leɪdibɜd/. Owing to this, 'ladybug' /leɪdibʌg/ was accepted as a correct response. The three participants in the pre-pilot study were able to follow one-step verbal instructions and answer simple questions (e.g., 'copy me' and 'what is this?'). Following the pre-pilot study, it was noted that between thirty and forty-five minutes had to be allocated for each assessment, and this was dependent on the child's attention span. This matched the time that was originally allocated per assessment. Although it was expected that the participants would require frequent breaks during the assessment, it was noted during the pre-pilot study that they were able to maintain focus and participate in the assessment tasks when the breaks provided included a sensory element. Owing to this, it was ensured that sensory toys (e.g., trampoline, exercise ball, stress balls etc.) were available during the assessments.

3.8 Data collection

Following the pre-pilot study, the remaining participants were assessed using the DEAP. Participants were assessed between 09/11/2021 and 06/12/2021. They were each assessed individually by the researcher in a quiet room on their school grounds. The responses obtained were transcribed by the researcher in real-time, using the IPA convention. Each assessment was recorded using a Bell Office voice recorder, model number DVR-6006 II, which allowed for improved reliability of transcriptions as the researcher was able to check them after each assessment. Only the researcher and researcher's supervisor had access to the audio-recordings to ensure confidentiality.

Each assessment lasted between thirty and forty-five minutes, and participants were assessed only once. Breaks were provided during the sessions, as needed. A visual schedule was used during the assessments to assist the participants in understanding what to expect during the sessions (Appendix K). A visual schedule uses pictures to demonstrate how activities will be sequenced and has been reported to improve understanding of activities and transitioning between activities in children with ASD (Dettmer, Simpson, Myles & Ganz, 2000). Once the assessment was concluded, each participant was rewarded with games of interest (e.g., blowing bubbles). The heads of the schools were provided with a summary of findings for each participant. This was sent home to the individual participants' parents and/or legal guardians.

3.9 Data analysis

Participants were assigned codes to ensure that confidentiality was maintained when recording and analysing results. Codes were assigned based on the first letter of the school's name and the order in which participants were assessed at each school (e.g., M01, M02, etc.). Results were reviewed descriptively according to relational and independent phonological analyses. Research findings were then described according to the following areas: (1) classification of SSDs; (2) intelligibility ratings (3) production of vowels; (4) production of consonants; (5) production of phonotactic structures; (6) the nature of phonological processes noted in the children's speech; (7) oro-motor skills; (8) consistent production of speech sounds; and (9) prosody.

Participants' speech errors were analysed and then classified according to Dodd's (2005) differential diagnostic framework. In this way, the analysis classified participants' speech according to the type of SSDs they presented with. Participants' scores for the seven questions in the ICS were added and each participant received a total score out of thirty-five. This score was then divided by seven, in order to provide an overarching idea of each participant's intelligibility rating.

Both independent and relational analyses were also used in describing participants' speech. Independent analysis involved a description of the participants' abilities to produce target phonemes, regardless of whether the target words were produced correctly (Baker, 2004). Each participant's realisation of phonemes, vowels and syllable structures were recorded.

Relational analysis, on the other hand, involved an examination of the accuracy of speech production by comparing incorrect productions to the target phonology (Baker, 2004). The relational analysis included a description of the phonological processes that participants presented with. Participants were recorded to present with a phonological process if the error pattern was present five or more times in their speech samples, apart from weak syllable deletion which only needed to be present twice (Dodd et al., 2002). Additionally, relational analysis involved obtaining a severity rating by calculating the percentage of vowels (PVC), percentage of consonant (PCC), percentage of phonemes (PPC), and syllable structures produced correctly. The formulae used to calculate these severity ratings are included below:

$$PVC = \frac{total\ number\ of\ vowels\ prduced\ correctly}{total\ number\ of\ vowels\ targeted} \times 100$$

$$PCC = \frac{total\ number\ of\ consonants\ prduced\ correctly}{total\ number\ of\ consonants\ targeted} \times 100$$

3.10 Validity and reliability

Validity is a test's ability to accurately assess that which it claims to assess (Terre Blanche, Durrheim & Painter, 2012). The research study aimed to evaluate the occurrence of SSDs in children with ASD, and through speech assessments and an analysis which described the speech characteristics and the prevalence of specific types of SSDs, this study can be said to be valid. A pre-pilot study was conducted in order to determine how well participants understood the presentation of instructions and cues, as well as, to ensure that adequate time was allocated to each assessment. The pre-pilot study increased the validity and reliability of the study by allowing the researcher to determine how to present the assessments consistently to give all participants an equal opportunity to perform their best. Additionally, the data from the pre-pilot study was able to be compared to the findings from the current study. Criterion-related validity is the degree to which a test is able to predict a standardised outcome (Terre Blanche et al., 2012). In order to achieve criterion-related validity, the researcher consulted literature within similar areas of study. In this way, the results of the current study were compared against previous data. Additionally, this study ensured that the tests used in the study were valid. The study made use of a standardised assessment tool (the DEAP), which ensured that the results obtained were able to be interpreted against evidence-based measures. Additionally, the researcher made evidence-based adaptations to the DEAP based on preliminary data of children acquiring South African English (SAE) (Pascoe et al., 2018). Secondly, content validity indicates the extent to which a test is representative of all aspects related to the research phenomenon (Terre Blanche et al., 2012). The study analysed and described all areas of speech, i.e., phoneme acquisition, phonological processes, oro-motor ability, severity indices, intelligibility ratings and the presentation of SSDs. Furthermore, the assessment used to assess the participants' speech (the DEAP) is comprehensive, allowing for accurate differential diagnoses to be established. This in turn allowed the researcher to determine the occurrence of SSDs within the study sample and to establish predictable patterns during data analysis.

Reliability is a test's ability to achieve consistent results (Terre Blanche et al., 2012). Intra-rater reliability refers to the consistency of results of repeated executions by a single rater (Gwet, 2014). Responses were transcribed twice by the researcher, which allowed for intra-rater reliability to be established. Responses were transcribed fully on two occasions, namely during the assessment and while listening to voice recordings after the sessions. Corrections were made to the initial transcriptions, where it was required, and an inter-rater reliability level of 98% was ensured. For example, during one of the initial transcriptions the voiceless velar stop /k/ was recorded as having been produced as voiced velar stop /g/. Following the re-transcription, it was noted that the participant actually produced the voiceless velar stop consonant /k/ correctly and this was then changed in the transcriptions accordingly. Additionally, the study made use of a second rater who transcribed 10% of the data, at an inter-rater level of 98% (Gisev, Bell & Chen, 2013). The second rater was a qualified SLT and organised their transcriptions according to the assigned participant codes, as the rater was not given the names of the participants in order to ensure confidentiality was maintained. The transcriptions of the two raters were compared and, where differences occurred, discussions were held in order for the raters to reach a consensus. Differences were noted to occur predominantly in transcriptions of voiced and voiceless consonant pairs. For example, the researcher transcribed the target word '**p**ig' /**p**ɪg/ as [**b**ɪg], while the second rater noted that the word was produced correctly as [pɪg]. In this instance, the researcher listened to the recording a third time and held a discussion with the second rater, where it was decided that the participant did in fact swap the voiceless bilabial stop /p/ for its voiced counterpart /b/. Both intra-rater and inter-rater reliability checks were done blind to the initial transcriptions.

3.11 Ethical considerations

The ethical considerations outlined by the Helsinki Declaration (World Medical Association, 2013) were upheld throughout the research period. These included:

3. 11.1 Autonomy and confidentiality

Autonomy refers to the requirement to obtain voluntary informed consent from all participants prior to commencing the study (Terre Blanche et al., 2012; World Medical Association, 2013). All parents and/or legal guardians were given information about the purpose of the study and provided with the opportunity to ask the researcher questions before providing consent. Parents and/or legal guardians were informed that they were able to withdraw their child from the study at any point without having to provide an explanation. Additionally, participants were given information on the study and were given the opportunity to provide verbal assent or refuse to participate. Information was provided to participants in a way that was easy for them to understand. The researcher used short, simple phrases and used pictures to supplement verbal descriptions.

Confidentiality is an important aspect in ensuring that autonomy and participant dignity is maintained (Terre Blanche et al., 2012; World Medical Association, 2013). In the present study, all participants were assigned a code. The names of the participants and their corresponding codes were kept separate. In this way, there was no identifying information when the results were analysed and reported. In addition, participants' names were not used while the assessments were being audio-recorded. The list linking the participants' names to their codes was shredded and destroyed. Audio-recordings and written transcriptions have been stored electronically on the researcher's personal electronic device. Both the device and the folder in which data was stored are password protected. Data will be stored for five years after the conclusion of the study as per the university guidelines. The researcher will be responsible for destroying all traces of the data.

3. 11.2 Non-maleficence

As an ethical principle, non-maleficence seeks to ensure that participants will incur no harm (Terre Blanche et al., 2012; World Medical Association, 2013). While no direct risks were identified for the present study, children with ASD are known to be a vulnerable population and therefore the utmost measures were taken to ensure that the participants felt comfortable and safe throughout the assessment process. The study was conducted on school grounds, to ensure that participants were in a safe and familiar environment. Participants were given breaks as needed during the assessment. Additionally, if participants had any sensory needs these were taken into account. For example, participants were provided with fidget toys as required or provided with a trampoline to jump on in between assessment subtests. Educators were asked to remind participants (verbally and using visuals) that they would be taking part in the study the day before and the morning of their assessment to help ease any anxieties surrounding changes to their daily routines.

3. 11.3 Beneficence

Beneficence seeks to maximise the benefits for the participant while minimising the risks (Terre Blanche et al., 2012; World Medical Association, 2013). Participants may not have benefitted directly from the study, however all participants received a free speech assessment as part of the study. Assessment summaries were provided to the schools and the parents and/or legal guardians. Participants who were observed to have a speech, language or other developmental and behavioural difficulties were recommended to attend assessments with the relevant healthcare professionals – if they were not already receiving support in these areas. The information obtained in the study may aid in improving understanding and subsequent intervention regarding SSDs in children with ASD. Additionally, the results of the study have contributed to the pre-existing knowledge regarding SSDs in children with ASD within the South African context.

3. 11.4 Justice

Justice is an ethical principle which requires researchers to treat all participants equally, from the selection of participants through to the completion of the study (Terre Blanche et al., 2012; World Medical Association, 2013). Additionally, according to the principle of distributive justice, minority groups should not be excluded from a research study (Greaney, 2012). Participants were not required to be home language English speakers, which allowed for inclusivity of more population groups. Furthermore, participants did not receive any favouritism in being selected for the study, participants were selected based on their availability and willingness to participate.

3.12 COVID-19 considerations

A mask, covering both nose and mouth, was worn by the researcher during data collection. During oro-motor assessments and in the moments where participants required modelling, a face shield was used in place of a face mask and this was done for short periods. The participants were not required to wear masks, as the researcher needed to evaluate their oro-motor skills while they spoke. However, participants were provided with a face shield that they were encouraged to wear throughout the assessment. The assessment room and all assessment resources were sanitised after each assessment. The researcher and the participants' hands were sanitised at the start and end of each assessment. Each assessment room was well ventilated. Additionally, social distancing between the researcher and the participant was ensured throughout the assessment.

3.13 Summary

This chapter has described the methods that were employed in the study and the rationale for their selection. These methods were described in detail to allow future researchers who are interested in this topic to replicate the study. The chapter described the study aims and objectives, the research design and the selection of participants. A descriptive, exploratory research design was employed to evaluate the occurrence of SSDs in 25 children with ASD aged 4;0 – 7;11 years. Data collection and data analysis procedures were then discussed. Additionally, this chapter indicated the ways in which the validity, reliability and ethical considerations were maintained throughout the study. The following chapter describes the findings of this study.

CHAPTER 4: RESULTS

In this chapter, the study findings are presented. Firstly, the participants' speech is described, and errors identified are classified according to Dodd's (2005) differential diagnostic framework. This is then followed by the independent analysis and relational analysis.

4. 1 Classification of SSDs

Participants' speech errors were analysed and then classified according to Dodd's (2005) differential diagnostic framework. In this way, the analysis classified participants according to the type of SSDs they presented with. The information is first presented as an overview, indicating the number of participants presenting with each type of SSD. This is followed by a description of each SSD and finally, participants' perceived intelligibility and whether they presented with an SSD is evaluated. Some participants in the study presented with more than one SSD, therefore not all graphs will have totals equal to *n*. The graph below reflects the number of participants who presented with each type of SSD, while the table gives such information for each participant.

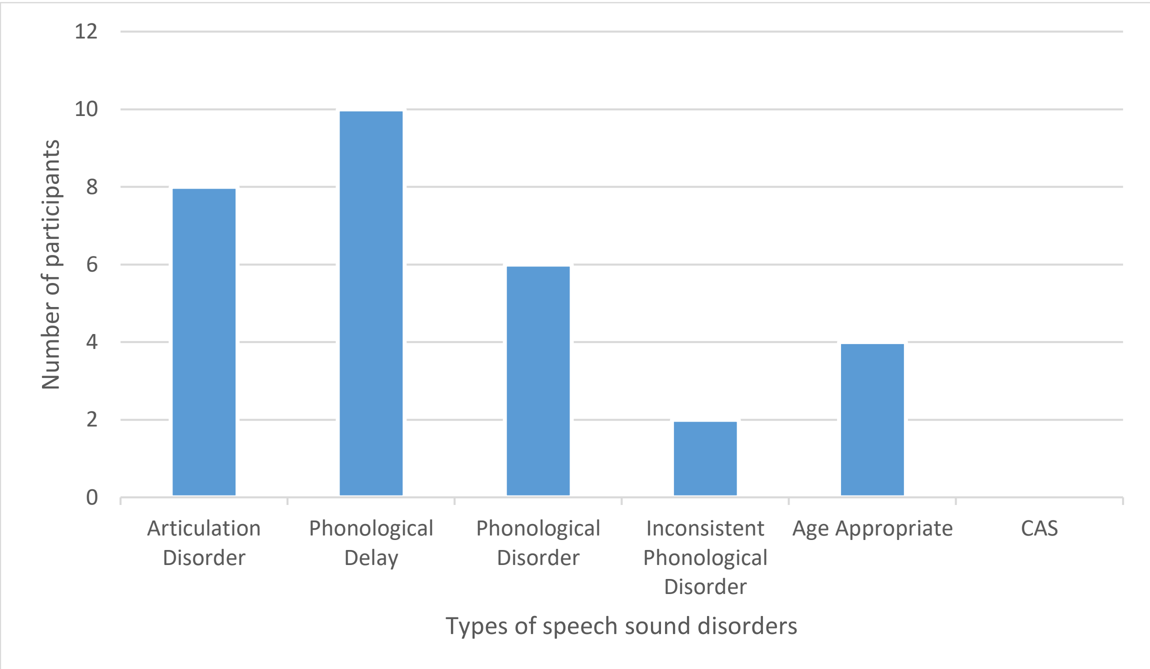

Figure 4. The occurrence of SSDs in children with ASD aged 4;0 – 7; 11 years

Table 5. Classification of SSDs in children with ASD aged 4;0 – 7;11 years

Participant (years; months)	Age-appropriate Speech	Articulation Disorder	Phonological Delay	Phonological Disorder	Inconsistent Phonological Disorder	CAS
M05 (4;3)			■			
MO4 (5;0)			■			
S01 (5;1)				■		
MO2 (5;3)			■			
SO2 (5;4)				■		
CO4 (5;4)					■	
AO4 (5;5)			■			
SO3 (5;5)	■					
C05 (5;11)			■			
CO7 (5;11)		■		■		
MO3 (6;0)			■			
MO1 (6;1)			■			
CO2 (6;1)	■					
EO2 (6;2)		■				
ECD2 (6;8)				■		
AO3 (6;10)			■			
EO5 (6;10)				■		
CO6 (7;0)			■			
ECD1 (7;1)		■				
CO3 (7;1)	■					
CO1 (7;3)		■		■		
ECD3 (7;5)		■			■	
ECD4 (7;5)		■	■			
EO1 (7;6)	■					
EO4 (7;7)	■					

Note: Grey blocks indicate that the participant presented with the SSD.

The table above summarises the types of SSDs each participant presented with. As reflected in the table, phonological delay was the most commonly occurring SSD in the study sample, with ten participants (40%) classified as presenting with a phonological delay. Participants were classified as having a phonological delay if the phonological processes that were present in their speech were typical but immature for their age (Dodd, 2005). For example, M05 (aged 4;3 years) presented with four phonological processes, two of which were immature for their age. The four phonological processes that M05 presented with were gliding of liquids, cluster reduction, velar fronting and stopping of fricatives. Gliding of liquids and cluster reduction were noted to be age appropriate for M05's age as the age of suppression for each phonological process is 5;11 and 4;11 years respectively (Dodd, 2005). Velar fronting is expected to be eliminated from a child's speech at 3;11 years and stopping of fricatives at 3;5 years, making both phonological processes inappropriate for M05 (Dodd, 2005).

Articulation disorders were observed in six participants (24%). Participants were diagnosed with an articulation disorder if they had consistent difficulty producing a speech sound in all contexts and in all word positions (Dodd, 2005). For example, C07 (aged 5;11 years) had difficulty producing the voiceless alveolar fricative /s/ in all word positions, syllables and in isolation and they were not stimulable for this sound during the assessment. The phoneme was substituted with either a voiceless palatal fricative /ʃ/ in words (for example, '**s**ock' /**s**ɑk/ was produced as [**ʃ**ɑk]) or voiceless labiodental fricative /f/ in syllables or isolation. If alveolar fricative /s/ was not substituted, it was noted to be omitted from words and syllables. In addition to substitutions, participants were recorded as presenting with an articulation disorder if speech sounds were consistently distorted in their speech. For example, E02 (aged 6;2 years) was noted to present with a lateral lisp. Voiceless alveolar fricative /s/ was distorted to sound like lateral fricative 'tlh' /ɬ/ in all word positions and in all contexts (e.g., '**s**au**s**age' /**s**ɒ**s**ɪʤ/ produced as [**ɬ**ɒ**ɬ**ɪʤ].

Six participants (24%) were diagnosed with a phonological disorder, making it the third most common SSD in this study population. A phonological disorder differs from a phonological delay in the sense that the phonological processes that the child presents with are unusual and non-developmental for the languages being acquired (Dodd, 2005). Participants were classified with a phonological disorder if they presented with both typical and atypical phonological processes or if they presented with only atypical phonological processes (Dodd, 2014). For example, participant S01 (age: 5;1 years) presented with delayed phonological processes (such as, cluster reduction, stopping of fricatives and final consonant deletion), age-appropriate phonological processes (gliding of liquids) and unusual errors (initial consonant deletion and affrication).

Inconsistent phonological disorders were recorded for two participants (8%). Participants were diagnosed with an inconsistent phonological disorder if they presented with different errors when producing the same sound in various contexts or word positions and if errors occurred in the absence of oro-motor difficulties (Dodd, 2005). Participant C04 (5;4 years) presented with several immature phonological processes across various target words (cluster reduction, velar fronting, stopping of fricatives and final consonant deletion), one age-appropriate phonological process (gliding of liquids) and one unusual phonological process (medial consonant deletion). Additionally, C04 obtained an inconsistency score of 40% on the DEAP, which classified their speech as inconsistent (Dodd, 2005). An example of an inconsistency within C04's speech is their production of the voiceless interdental fricative /θ/ which was replaced by various stop consonants, including /t, p, b/, and the voiceless labiodental fricative /f/. For example, 'tee**th**' /ti**θ**/ was produced as [ti**f**], [ti**p**] and [ti**t**] during the assessment. Additionally, voiceless labiodental fricative /θ/ was produced differently each time. For example, '**th**umb' /**θ**ʌm/ was produced as [**f**ʌm] and [**t**ʌm] on different occasions.

Four participants (16%) were recorded as presenting with age-appropriate speech. Age-appropriate speech was more common in the sample than inconsistent phonological disorders (which was seen in two participants). Participants were noted to have age-appropriate speech either if they had no speech sound errors or if the errors they presented with were typical for their age. For example, S03 (aged 5;5 years) was recorded as having age-appropriate speech even though they presented with one phonological process (gliding of liquids) and two speech sounds were missing from their phonetic inventory (namely, the voiceless interdental fricative /θ/ and the voiced palatal liquid /ɹ/). Gliding of liquids is expected to be eliminated from a child's speech at around 5;11 years, making it an age-appropriate error in S03's speech (Dodd, 2005). Furthermore, children are only expected to acquire the voiceless interdental fricative /θ/ and the voiced palatal liquid /ɹ/ after 7;0 years old and between 6;0 – 6;5 years, respectively (Dodd et al., 2003).

From the study sample, none of the participants presented with signs of CAS. Two participants (C04 and ECD3) presented with inconsistent errors, but no oro-motor difficulties, vowel errors, inconsistent nasality or prosody were noted in their speech. They were therefore diagnosed with an inconsistent phonological disorder rather than CAS.

Four participants (16%) were observed to present with co-occurring SSDs. Two participants (8%) (C07 and C01) presented with features of an articulation disorder as well as a phonological disorder. One participant (4%) (ECD4) presented with errors associated with an articulation disorder and a phonological delay. Finally, one participant (4%) (ECD3) was observed to have both an articulation disorder and an inconsistent phonological disorder.

The Intelligibility in Context Scale (ICS) (McLeod et al., 2012) was used to obtain an understanding of each participant's intelligibility in a variety of contexts. The ICS was given to parents and/or legal guardians to complete. Table 6 provides information on the number of participants who obtained specific scores for each question in the ICS.

Table 6. Number of participants who obtained each score in the ICS

Question	Number of participants				
	Always (5)	**Usually (4)**	**Sometimes (3)**	**Rarely (2)**	**Never (1)**
1. Do you understand your child?	8	13	4		
2. Do immediate members of your family understand your child?	5	10	6	4	
3. Do extended members of your family understand your child?	3	7	10	5	
4. Do your child's friends understand your child?	2	14	5	2	2
5. Do other acquaintances understand your child?	1	4	11	6	2
6. Do your child's teachers understand your child?	8	14	3		
7. Do strangers understand your child?	1	6	9	4	5

The table above summarises how many participants obtained a specific intelligibility rating for each question of the ICS. As seen in the table, most participants were given higher intelligibility ratings ('sometimes', 'usually' and 'always') for questions related to how well they are understood by their parents and/or legal guardians, peers, and teachers. No participant received scores of 'rarely understood' or 'never understood' by their parents and/or legal guardians and their teachers. Noteworthily, 5 participants (20%) were recorded as 'never' understood by strangers, while only 1 participant (4%) was recorded as 'always' understood by strangers. This information is in agreement with the literature, suggesting that children are more intelligible to familiar communication partners (McLeod et al., 2012). Thirteen (52%) parents and/or legal guardians indicated that they 'usually' understood their child's speech. Fourteen (56%) parents and/or legal guardians indicated that their children are ‘usually’ understood by their teacher. Eight parents and/or legal guardians (32%) noted that they ‘always’ understood their child. This same number of children were reported as being ‘always’ understood by their teachers. The remaining responses indicated that four (16%) parents and/or legal guardians ‘sometimes’ understood their child and three (12%) believe that their child is ‘sometimes’ understood by their teacher. These results suggest that children are most intelligible to their parents and/or legal guardians and their teachers.

The ICS scores showed that ten (40%) of the participants’ immediate family members ‘usually’ understood them. On the other hand, 7 (28%) participants were rated as ‘usually’ understood by extended family members. Eleven participants (44%) were reported to be ‘sometimes’ understood by acquaintances. Nine (36%) parents and/or legal guardians reported that strangers ‘sometimes’ understood their child, 6 (24%) ‘usually’ do and only one (4%) reported that they ‘always’ do. More parents and/or legal guardians reported that their children are less likely to be understood by a stranger, with 4 (16%) scoring their child as ‘rarely’ understood and 5 (20%) as ‘never’ understood by a stranger. Participants’ scores for the 7 questions in the ICS were added and each participant received a total score out of 35. This score was then divided by 7, in order to provide an overarching idea of each participant’s intelligibility rating. Total scores were analysed according to whether participants presented with an SSD and the type of SSD they presented with. These findings are presented in the graph below.

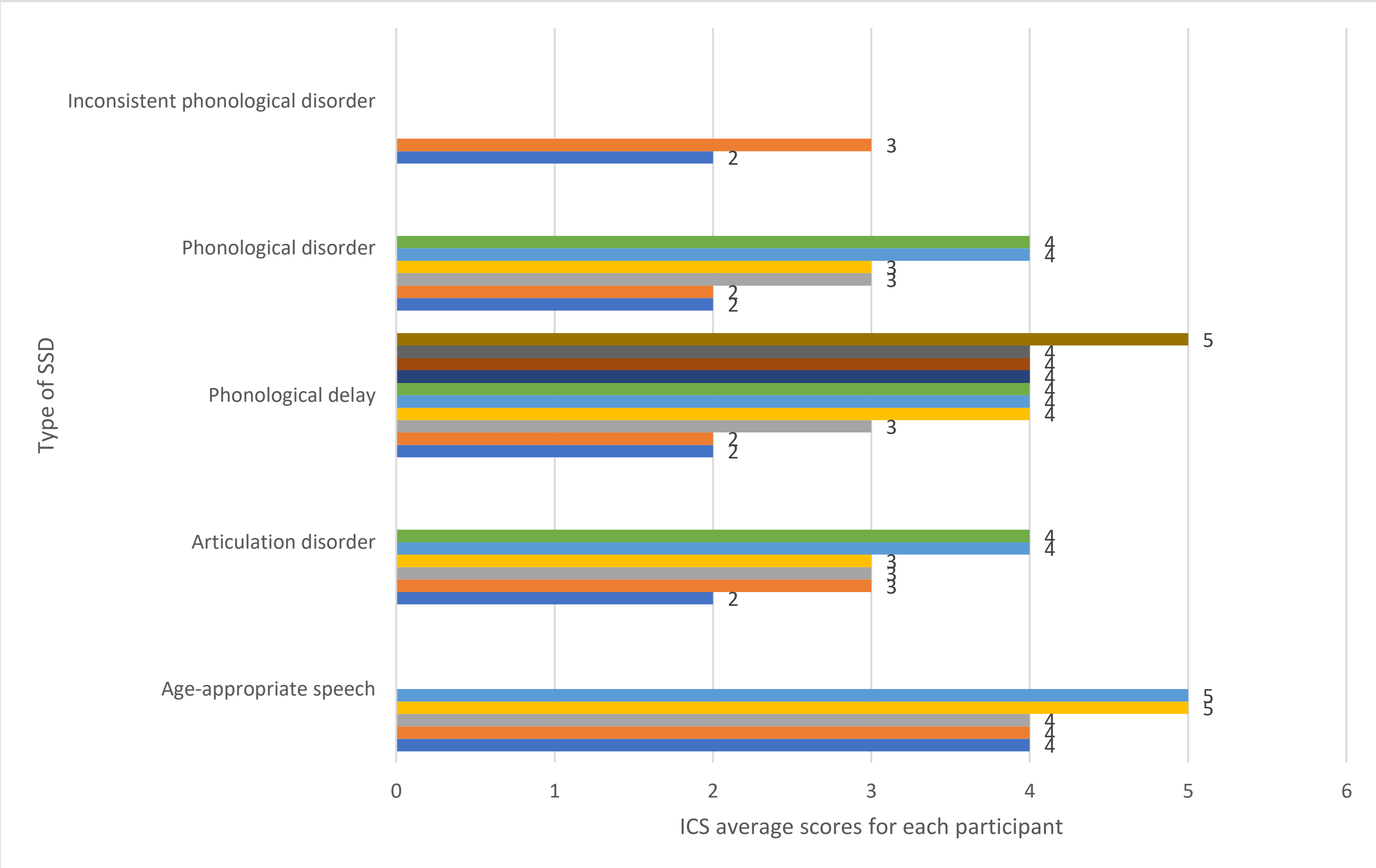

Figure 5. ICS total scores in comparison to the classification of SSDs

Figure 5 above provides information on the participants' total intelligibility scores in relation to the type of SSD they were diagnosed with. Each column in the table represents a single participant. It was noted that participants who presented with age-appropriate speech had the highest intelligibility scores of four and five (average score of 3.6 for all five participants). The second most intelligible group was noted to be participants with a phonological delay, with scores ranging between two and five (average score of 3.6). Third, were participants with articulation disorders. These participants obtained total intelligibility scores between two and four (average score of 3.2). Participants with phonological disorders also obtained scores between two and four (average score of 3). Finally, participants who presented with inconsistent phonological disorder were noted to be least intelligible, having obtained scores between two and three (average score of 2.5).

The following section (independent analysis) describes participants' production of vowels, consonants and phonotactic structures.

4. 2 Independent Analysis

The independent analysis describes each participant's phonetic inventory, noting both consonants and vowels. Consonants and vowels that were produced spontaneously and that a participant was stimulable for were recorded as being present in their phonetic inventory. Table 7 depicts the consonant phonemes that were present in each participant's phonetic inventory.

Table 7. Consonants present in the participants' phonetic inventories

Consonants		M0 5	M0 4	S0 1	M0 2	S0 2	C0 4	A0 4	S0 3	C0 5	C0 7	M0 3	M0 1	C0 2	E0 2	ECD 2	A0 3	E0 5	C0 6	ECD 1	C0 3	C0 1	ECD 3	ECD 4	E0 1	E0 4
Stops	p																									
	b																									
	t																									
	d																									
	k																									
	g																									
Fricatives	f																									
	v																									
	θ																									
	ð																									
	s																									
	z																									
	ʃ																									
	ʒ																									
	h																									
Affricates	ʧ																									
	ʤ																									
Nasals	m																									
	n																									
	ŋ																									
Liquids	l																									
	ɹ																									
Glides	w																									
	j																									

Note: Grey blocks indicate that the phoneme was present in the participants’ phonetic inventory.

The voiceless interdental fricative /θ/ was absent from the phonetic inventories of 13 participants (52%). Among these participants, /θ/ was replaced with either the voiceless alveolar stop /t/ or voiceless labiodental fricative /f/ in words, syllables and in isolation. Dialectal variations in South African English for bilingual Afrikaans-English and isiXhosa-English speaking children, allowed for the researcher to accept certain substitutions in the word-final position. For example, C03 (age: 7;7 years) who was reported to speak Afrikaans at home consistently replaced the voiceless interdental fricative /θ/ with voiceless labiodental fricative /f/. For instance, 'tee**th**' /ti**θ**/ was realised as [ti**f**] and '**th**umb' **θ**ʌm/as [**f**ʌm]. The second most commonly missing phoneme from participants' phonetic inventories was the voiced interdental fricative /ð/. This phoneme was missing from the phonetic inventories of 7 participants (28%). It was replaced consistently by the voiced alveolar stop /d/. This substitution is noted in adult phonology for bilingual Afrikaans-English speakers. For example, '**th**is' /**ð**ɪs/ was produced as [**d**ɪs] and 'fea**th**er' /fɛðə/ was produced as [fɛ**d**ə] and in syllables, '**th**y' /**ð**ai/ as [**d**ai] and in isolation. The voiceless labiodental fricative /f/ was missing from the phonetic inventories of three participants (M04, S02, ECD3). It was consistently substituted with voiceless bilabial stop /p/ by M04 (5;0 years) and ECD3 (7;0 years). S02 (5;4 years) was observed to replace this phoneme with the voiceless bilabial stop /p/ in the word-final position and bilabial glide /w/ in the word-initial position. For example, 'kni**f**e' /nai**f**/ was produced as [nai**p**] and '**f**ish'/**f**ɪʃ/ was produced as [**w**ɪʃ]. The voiced palatal fricative /ʒ/ was also absent from the phonetic inventories of 3 participants (S01: 5;1 years, S02: 5;4 years, C07: 5;11 years). It was replaced with voiceless alveolar fricative /s/ by all 3 participants. For example, 'televi**si**on' /tɛləvɪ**ʒ**ən/ was produced as [tɛləvɪ**s**ən].

As noted in table 7, voiceless alveolar fricative /s/ was not present in the phonetic inventories of 3 participants (E02: 6;8 years, ECD3: 7;5 years; C07: 5;11 years). E02 presented with a lateral lisp, and the voiceless alveolar fricative /s/ was distorted to sound like latero-alveolar fricative /ɬ/in all word positions, in syllables and in isolation. ECD3 consistently replaced /s/ with the voiceless palatal affricate /ʧ/, for example '**s**ock' /**s**ɒk/ became [**ʧ**ɒk] and 'hou**s**e' /haʊ**s**/ was produced as [haʊ**ʧ**]. The substitution of /s/ for /ʧ/ is considered as affrication, a phonological process. However, ECD3 was not stimulable for correct production of /s/ in syllables or in isolation, which allowed the researcher to mark this sound as missing from the participant's phonetic inventory. One participant (M05: 4;3 years) had voiceless palatal fricative /ʃ/ missing from their phonetic inventory. M05 consistently substituted /ʃ/ with alveolar fricative /s/ (e.g., '**sh**eep' /**ʃ**ip/ was produced as [**s**ip]).

Three participants (M04: 5;0 years, C07: 5;11 years, ECD2: 6;8 years) had not acquired the voiceless palatal affricate /ʧ/. All 3 participants substituted this phoneme for either the voiceless alveolar fricative /s/ or palatal /ʃ/. For example, '**ch**air' /**ʧ**εə/ was produced as [**s**εə] and 'wat**ch**' /wɔ**ʧ**/ as [wɔ**ʃ**].

The voiced palatal liquid /ɹ/ had not been acquired by five participants (20%). Among all 5 participants, the phoneme was recorded to have been substituted with the voiced bilabial glide /w/ in all word positions, syllables and in isolation. For example, '**r**ing' /**ɹ**ɪŋ/ was produced as [**w**ɪŋ] and 'zeb**r**a' /zεb**ɹ**ə/ as [zεb**w**ə]. The alveolar liquid /l/ was not present in the speech of 2 participants (M05: 4;3 years, M04: 5;0 years). Both participants consistently replaced the alveolar liquid /l/ with the bilabial glide /w/. For example, '**l**eg' /**l**εg/ was produced as [**w**εg].

Next, vowel inventory is discussed. The table below indicates the vowel phonemes that were present in each participant's phonetic inventory.

Table 8. Vowels present in the participants' phonetic inventories

Vowels		M05	M04	S01	M02	S02	C04	A04	S03	C05	C07	M03	M01	C02	E02	ECD2	A03	E05	C06	ECD1	C03	C01	ECD3	ECD4	E01	E04
Front	i	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɪ	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɛ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	a	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Central	ə	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɜ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Back	u	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ʌ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■
	ʊ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɒ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɑ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɔ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Diphthongs	ɪə	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	eɪ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɔɪ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɑɪ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	ɑʊ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	oʊ	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Note: Grey blocks indicate that the phoneme was present in the participants' phonetic inventory.

The present study noted two vowel phonemes that were missing from the phonetic inventories across the sample. The front high vowel /ɪ/ was missing from M04's (5;0 years) inventory. M04 was recorded as having substituted /ɪ/ with front open-mid /ɛ/, in this way words such as '**fi**sh'/f**ɪ**ʃ/ were produced as [f**ɛ**ʃ]. Secondly, back open-mid /ʌ/ was missing from ECD4's (7;7 years) inventory. ECD4 consistently replaced the back open-mid vowel /ʌ/ with the back vowel /ɔ/ so that words like 'd**u**ck' /d**ʌ**k/ were produced as [d**ɔ**k] and 'gl**o**ves' /gl**ʌ**vz/ as [gl**ɔ**vz].

Vowel and consonant combinations (phonotactic structures) are described next. Table 9 summarises the number of participants who produced the different syllable structures.

Table 9. Phonotactic structures produced by participants

Phonotactic structure	Number of syllables	Example	Number of Participants		Phonotactic structure	Number of syllables	Example	Number of Participants
V	1	‘ear’ /ɪə/	25		**CVCVC**	2	‘giraffe’ /ʤəɹɑf/	20
VC	1	‘egg’ /ɛg/	23		**CVCCVC**	2	‘lighthouse’ /laɪthaʊs/	22
CV	1	‘boy’ /bɔɪ/	25		**CVCCCV**	2	‘thank you’ /θaŋkju/	20
CVC	1	‘pig’ /pig/	25		**CVCCVCC**	2	‘biscuits’ /bɪskɪts/	18
CCV	1	‘three’ /θɹi/	20		**CCCVCCV**	2	‘strawberry’ /stɹɔbɹi/	21
CVCC	1	‘jump’ /ʤʌmp/	24		**CVCCCVC**	2	‘toothbrush’ /tuθbɹʌʃ/	21
CCVC	1	‘bread’ /bɹɛd/	20		**CVCVCV**	3	‘tomato’ /təmɑtoʊ/	21
CCVCC	1	‘gloves’ /glʌvz/	20		**VCVCVCC**	3	‘elephant’ /ɛləfənt/	20
CCCVC	1	‘splash’ /splaʃ/	18		**CVCVCVC**	3	‘ladybug’ /leɪdibʌg/	22
CVCV	2	‘yellow’ /jɛloʊ/	25		**VCCCVCV**	3	‘umbrella’ /ʌmbɹɛlə/	20
VCVC	2	‘apple’ /apəl/	24		**CVCCVCVC**	3	‘birthday cake’ /bɛθdeɪkeɪk/	21
CVCCV	2	‘zebra’ /zɛbɹə/	24		**CCVCCVCCVC**	3	‘slippery slide’ /slɪpɹislaɪd/	18
VCVCC	2	‘orange’ /ɒɹɪnʤ/	24		**CVCVCVCVC**	4	‘television’ /tɛləvɪʒən/	20
CCVCV	2	‘spider’ /spaɪdə/	18		**CVCVCVCCV**	4	‘helicopter’ /hɛlikɒptə/	22

At least 80% of participants (20 or more) were able to produce words of up to four syllables. There were several phonotactic structures (namely, CCCVC, CCVCV, CVCCVCC, CCVCCVCCVC) that appear to still be developing across the sample, with less than 80% of participants having been recorded as producing these structures correctly. Participants presented with phonological processes when producing these phonotactic structures, specifically: cluster reduction, weak syllable deletion and final consonant deletion. This is described in the section that follows.

4. 3 Relational Analysis

In this section, the percentage consonants correct (PCC), percentage vowels correct (PVC) and percentage phonemes correct (PPC) are described for each participant. Additionally, the phonological processes that participants presented with are described in order to compare their speech to the adult (target) phonology. This is followed by a description of participants' prosody and oro-motor skills. Severity indices (PCC, PVC, PPC) were calculated based on the participants' production of words during the phonology assessment of the DEAP. The severity indices are presented first (seen in table 10), followed by an analysis of the phonological processes that participants presented with.

Table 10. Severity indices for each participant

Participants (age in years; months)	PCC (%)	PVC (%)	PPC (%)
M05 (4;3)	81	100	88
M04 (5;0)	77	92	83
S01 (5;1)	79	99	86
M02 (5;3)	93	100	95
S02 (5;4)	66	97	77
C04 (5;4)	80	95	85
A04 (5;5)	90	100	93
S03 (5;5)	90	100	93
C05 (5;11)	81	100	88
C07 (5;11)	72	100	83
M03 (6;0)	87	100	92
M01 (6;1)	81	95	86
C02 (6;1)	96	100	98
E02 (6;2)	83	100	89
ECD2 (6;8)	85	97	90
A03 (6;10)	88	100	92
E05 (6;10)	96	100	98
C06 (7;0)	82	100	89
ECD1 (7;1)	92	100	95
C03 (7;1)	94	100	96
C01 (7;3)	72	90	80
ECD3 (7;5)	63	91	73
ECD4 (7;5)	92	100	95
E01 (7;6)	98	100	99
E04 (7;7)	96	100	75

Although this study did not aim to analyse participants' speech across age groups, it was noted that the older participants generally obtained higher PCC scores as compared to the younger ones. Seven participants (M02, S03, C02, E05, ECD1, E01, E04) presented with PCC scores above 90%, approximating adult speech. They obtained PVC scores of 100% and were noted to have age-appropriate speech. These participants presented with either complete phonetic inventories (E01, E04, E05) or were missing phonemes that were noted to be typical for their age (M02, C02, S03, ECD1). Participants who presented with lower PCC scores presented with a higher percentage of inaccuracies in their speech. For example, ECD3 presented with a PCC score of 63% and additionally was noted to have three phonemes missing from their phonetic inventory, as well as, the presence of 2 phonological processes (1 of which was immature and another atypical). No trends were observed between the type of SSD and severity indices. All participants presented with PVC scores of 90% and above.

The phonological processes that participants presented with are indicated in Table 11. The table shows the most commonly occurring substitutions for each phonological process.

Table 11. Number of participants presenting with phonological processes

Phonological Process	Realisation	Example	Number of participants (% of sample)
Stopping of fricatives	/θ/ → /t/ /ð/ → /d/ /v/ → /b/ /f/ → /p/	‘tee**th**’/ti**θ**/ → [ti**t**] ‘**th**is’ /**ð**ɪs/ → [**d**ɪs] ‘glo**v**es’ /glʌ**v**z/ → [glʌ**b**z] ‘**f**ive’ /**f**aɪv/ → [**p**aɪv]	18 (72)
Gliding of liquids	/l/ → /w/ /ɹ/ → /w/	‘e**l**ephant’ /ɛlefənt/ → [ɛ**w**efənt] ‘t**r**ain’ /tɹeɪn/ → [t**w**eɪn]	15 (60)
Cluster reduction	/sk/ → /k/ /spl/ → /p/ /stɹ/ → /t/ /sn/ → /n/	‘**sq**uare’ /**sk**wɛə/ → [kwɛə] ‘**spl**ash’ /**spl**aʃ/ → [paʃ] ‘**str**awberry’ /**stɹ**ɔbwi/ → [tɔbwi] ‘**sn**ake’ /**sn**eɪk/ → [seɪk]	12 (48)
Velar fronting	/k/ → /t/ /ŋ/ → /n/ /g/ → /d/	‘**c**rab’ /**k**ɹab/ → [**t**ɹab] ‘swi**ng**’ /swi**ŋ**/ → [swi**n**] ‘**g**ive’ /**g**iv/ → [**d**iv]	9 (36)
Initial consonant deletion		‘**th**ank you’ /**θ**aŋkju/ → [aŋkju] ‘**d**uck’ /**d**ʌk/ → [ʌk]	7 (28)
Palatal fronting	/ʃ/ → /s/	‘**sh**eep’ /**ʃ**ip/ → [**s**ip]	6 (24)
Final consonant deletion		‘elephan**t**’ /ɛlefən**t**/ → [ɛlefən]	6 (24)

Weak syllable deletion		‘**um**brella’ /**ʌm**bɹɛla/ → [bɹɛla] ‘e**le**phant’ /ɛ**le**fənt/ → [ɛfənt]	5 (20)
Medial consonant deletion		‘too**th**brush’ /tu**θ**bɹʌs/ → [tu-bɹʌs]	4 (16)
Context sensitive voicing	/p/ → /b/ /k/ → /g/	‘pig’ /pig/ → [**b**ig] ‘**c**rab’ /**k**ɹab/ → [**g**ɹab]	3 (12)
Affrication	/t/ → /ʧ/ /ʃ/ → /ʧ/	‘**t**rain’ /**t**reɪn/ → [**ʧ**eɪn] ‘**sh**eep’ /**ʃ**ip/ → [**ʧ**ip]	3 (12)
Backing	/d/ → /g/	‘spi**d**er’ /spaɪ**d**ə/ → [spaɪ**g**ə]	2 (8)
Deaffrication	/ʤ/ → /d/ /ʧ/ → /ʃ/	‘**g**iraffe’ /**ʤ**əwaf/ → [**d**əwaf] ‘wat**ch**’ /wɔ**ʧ**/ → [wɔ**ʃ**]	2 (8)
Denasalisation	/m/ → /p/ /n/ → /p/	‘to**m**ato’ /tə**m**atoʊ/ → [tə**p**atoʊ] ‘**kn**ife’ /**n**aɪf/ → [**p**aɪf]	1 (4)
Consonant harmony		‘tomato’ /təmɑtoʊ/ → [**m**əmɑ**m**oʊ] ‘**k**itchen’ /**k**ɪʧən/ → [**ʧ**ɪʧən]	1 (4)

Stopping of fricatives was the most common phonological process in this sample and was seen in 18 participants (72%). The voiceless interdental fricative /θ/ and voiced /ð/ were the most frequently stopped phonemes. Gliding of liquids was observed in 15 participants (60%). Gliding occurred on both the voiced alveolar liquid /l/ and the voiced palatal liquid /ɹ/ for 5 of the 15 participants (M05, S02, C04, C06, C01). Four of the five participants substituted both phonemes with velar glide /w/, while one participant (C01) replaced them with a voiced palatal glide /j/. Eight of the participants (M04, M02, S03, C05, A04, M03, M01, ECD3) only glided on /ɹ/, replacing it with /w/ (M04, M02, S03, C05, A04, M03, M01) or /j/ (ECD3). One participant (ECD2) only glided the voiced alveolar liquid /l/, replacing it with /j/. Cluster reduction was present in the speech of 12 participants (48%). The most common clusters that were reduced by participants were those containing voiceless alveolar fricative /s/ (i.e., /sp, st, sn, sk/). Two of the 12 participants reduced all clusters targeted in the assessment. Nine participants (36% of the sample) presented with velar fronting. Four of these nine participants fronted only the voiceless velar stop /k/ and replaced it with voiceless alveolar stop /t/. Five participants fronted only velar nasal /ŋ/ with the alveolar /n/. Two participants replaced both the voiceless velar stop /k/ and the voiced /g/ with voiceless alveolar /t/ and voiced /d/ respectively. Six participants (24%) were noted to present with palatal fronting. Final consonant deletion was observed in the speech of 6 participants (24% of the sample). Five participants (20%) were noted to present with weak syllable deletion. Context sensitive voicing was observed in 3 participants (12% of the sample). Context sensitive voicing errors were typically noted as voiceless velar stop /k/ being replaced by voiced velar stop /g/, and the voiceless bilabial stop /p/ being replaced by the voiced bilabial stop /b/. Two participants (8%) presented with deaffrication. Both participants substituted palatal affricate sounds /ʧ, ʤ/ with voiceless palatal fricative /ʃ/ and the voiced alveolar stop /d/ respectively. One participant (C07) (4% of the sample) was recorded as presenting with consonant harmony. Finally, five unusual error patterns were observed among the sample, namely: initial consonant deletion (seven participants); medial consonant deletion (four participants); affrication (three participants); backing (two participants); and denasalisation (one participant).

Prosody was assessed informally throughout each assessment. The researcher is a native English speaker, and so, prosody was assessed subjectively. All participants were observed to use appropriate stress during the single word naming task and in conversational speech. Inaccurate use of tone, namely monotone, was recorded during conversational speech for four participants (16%) (C01, C07, ECD2 and A03). Participants C01 and C07 presented with co-occurring articulation disorders and phonological disorders, ECD2 presented with a phonological disorder and A03 presented with a phonological delay.

Oro-motor functioning was assessed using the oro-motor examination subtest of the DEAP. The assessment evaluated participants' ability to perform isolated and sequential non-speech oro-motor movements, as well as their diadochokinetic (DDK) rates. Participants were given a score for each subtest, total scores were: 9 for DDK rates, 12 for isolated movements and 18 for sequenced movements. Table 12 provides the DEAP normative data for the oro-motor subtests. This is followed by table 13, which provides information on how many participants obtained average range scores for diadochokinetic rates and isolated, sequenced movements.

Table 12. Minimum scores participants needed to obtain average range scores according to the DEAP normative data (Dodd et al., 2002, p.66 - 74)

Age range (years)	DDK rates	Isolated movements	Sequenced movements
4;0 – 4;5	2	8	7
4;6 – 4;11	6	9	8
5;0 – 5;5	6	11	10
5;6 – 5;11	6	11	13
6;0 – 6;5	6	12	16
6;6 – 6;11	8	12	16

Table 13. Number of participants who achieved average range oro-motor scores

DDK rates	Isolated movements	Sequenced movements
17	22	19

As can be seen in table 13, most participants presented with average oro-motor skills. Seventeen participants (68%) presented with average DDK rate scores, 22 (88%) with average scores for the isolated movements subtest and, 19 (76%) with average range scores for sequenced movements. Eight participants (32%) presented with below average DDK rate scores. These 8 participants presented with a mix of SSDs. The DDK rate subtest was scored according to sequence of phonemes, intelligibility, and fluency of production. Participants were given scores ranging from 0 to 3. Table 14 shows how many participants obtained each score for the specific scoring criteria in the DDK subtest.

Table 14. Number of participants obtaining each score in the DDK subtest

	Score			
	3	**2**	**1**	**0**
Correct sound sequence	10	6	5	5
Intelligibility	13	8	5	0
Fluency	10	7	7	2

As can be seen in table 14, most participants obtained a score of 3 for phoneme sequence, intelligibility, and fluency. Intelligibility appeared to be an area of strength in this task across the participants. Thirteen participants (52%) obtained a score of 3, eight (32%) a score of 2 and 5 (20%) a score of 1 for intelligibility. No participants were given a score of 0 for intelligibility for this subtest. Five participants (20%) obtained a score of 0 for correct sound sequence, suggesting that moving from bilabial to alveolar to velar phonemes was more challenging for participants than it was to produce the phonemes intelligibly or fluently.

4. 4 Summary

The results of the study were presented and described in this chapter. Overall, phonological delays were noted to be the most commonly occurring SSD in the sample, with 40% of participants presenting with a phonological delay. All participants were observed to have all stops, nasals, and glides in their phonetic inventories. Fricatives, affricates, and liquids were noted to be challenging for the participants. This study noted two vowel sounds that were missing from the phonetic inventories across the sample. It was noted that seven participants presented with PCC scores above 90%, approximating adult phonology. Higher PCC scores were noted in older participants as compared to the younger ones. Additionally, it was expected that lower PCC scores correlated with a higher prevalence of errors. All participants presented with higher PVC than PCC scores and all PVC scores were above 90%. The most commonly occurring phonological process was observed to be stopping of fricatives, with 72% of participants having presented with this phonological process. The following chapter evaluates and interprets the study findings in greater detail.

CHAPTER 5: DISCUSSION

This study aimed to describe the type and severity of SSDs in 25 children with ASD aged 4;0 – 7;11 years. This was done to contribute to the understanding of SSDs in children with ASD, an area that is under-researched in South Africa and globally. An improved understanding of the occurrence of SSDs will allow for SLTs and other education and healthcare professionals to better assess and manage children with ASD. The Diagnostic Evaluation of Articulation and Phonology (DEAP) was used to assess participants' oro-motor function and speech sound production (articulation, phonology, and the ability to produce speech sounds consistently). This chapter provides a detailed interpretation and discussion of the study findings.

5. 1 The occurrence of SSDs in children with ASD

Twenty of the 25 participants (80%) in this study presented with an SSD, supporting the theory that SSDs are prevalent among children with ASD. This figure is considerably higher than previous studies which have been conducted on children with ASD, where SSDs have been recorded to occur in between 21 and 41% of this population (Chenausky et al., 2019; Cleland et al., 2010; Kjellmer et al., 2018; Rapin et al., 2009; Shriberg et al., 2011;). This may be because of the relatively small sample size in this study (25 participants) in comparison to previous research, with samples between 46 and 208 participants. Phonological delays were the most commonly occurring SSDs, followed by articulation disorders, phonological disorders and, lastly, inconsistent phonological disorders. These results support the findings of previous studies that have recorded phonological delays to be the most commonly occurring SSD in children aged 3;0 – 6;0 years (Dodd, 2014; Ttofari, Eadie, Morgan & Reilly, 2019). Studies evaluating SSDs in children with ASD have also noted that phonological delays are the most commonly occurring SSD (Cleland et al., 2010). Dodd (2014) noted that 55% of children who present with an SSD, will present with a phonological delay. In South Africa, 75% of children diagnosed with an SSD were reported to present with phonologically delayed speech (Pascoe et al., 2018). The results of the present study are in line with those reported in the literature, with 40% of children with an SSD presenting with a phonological delay. These results suggest that children with ASD who present with SSDs may be as likely, or less likely, than their typically developing peers to present with a phonological delay.

Second to phonological delays, articulation disorders were the second most commonly occurring SSD in the present study, noted in 32% of participants (*n*=8). Previous studies on speech development have found articulation disorders to occur in 10–12% of typically developing children with an SSD (Dodd, 2014; Pascoe et al., 2018). In this way, children with ASD in South Africa appear more likely to present with an articulation disorder than their typically developing peers. Therefore, greater efforts should be made to ensure that speech assessments are consistently included in assessment batteries to ensure that articulation errors are detected and targeted alongside other possible language and social communication goals. Of note, a discrepancy in the occurrence of articulation disorder in children with ASD has been noted in previous research. Some studies have indicated that articulation is a relative strength in this population (Kjelgaard & Tager-Flusberg, 2001). However, other studies, similar to the present study, noted articulation disorders to be prevalent in children with ASD (Cleland et al., 2010; Rapin et al., 2009; Shriberg et al., 2011). These discrepancies may be a result of the methods used to assess speech, as well as the analysis of the results. For example, Kjelgaard and Tager-Flusberg (2001) scored responses on an articulation assessment as either correct or incorrect, without providing information as to the types and frequency of any errors. This may have led to results underestimating the presence of articulation difficulties in their sample (Cleland et al., 2010).

Following articulation disorders, phonological disorders were observed as the third most commonly occurring SSD. In this study, 24% of participants presented with a phonological disorder. These results are higher than previous studies conducted on typically developing children which indicated phonological disorders to occur in 7–10% of children with an SSD (Dodd, 2014; Pascoe et al., 2018). The findings suggest that children with ASD may be more likely to present with unusual error patterns than their typically developing peers. ASD is a neurodevelopmental disorder, and the development of speech in this population is not yet well researched. In this way, what may be considered an unusual error pattern in typically developing children, could be more common among children with ASD. This finding may be something for SLTs to note when scoring speech assessments for children within this population.

Finally, inconsistent phonological disorders were observed in 8% of the study sample. These findings correspond with the literature, which has reported inconsistent phonological disorders to be present in 4–10% of typically developing children (Dodd, 2014; Pascoe et al., 2018). Age-appropriate speech was recorded in 16% of participants. None of the participants in the study met the diagnostic criteria for CAS. This may have been due to the relatively small sample size and/or due to the criteria applied in selecting participants for the study. Participants in this study had to have a certain level of verbal language abilities to take part. According to the CAS-ASD hypothesis proposed by Shriberg et al. (2011), CAS is the underlying cause of delayed language development in children with ASD. In this way, non-verbal or minimally verbal children would need to be assessed for CAS. If this hypothesis is considered while analysing the results of the present study, it could be suggested that participants in the sample were not found to meet the assessment criteria for CAS because they were all verbal.

5. 1. 1 Classification of SSDs using the Differential Diagnostic Framework

In the present study, the classification of a single SSD using Dodd's (2005) differential diagnostic framework was not absolute, and 16% of participants (*n=4*) presented with features characteristic of two different SSD subtypes. Articulation disorders were noted to co-occur with phonological disorders in 8% of participants, phonological delays in 4% and inconsistent phonological disorders in 4%. These results are in line with those documented by Dodd, Reilly, Eecen and Morgan (2018), stating that articulation and phonological delays/disorders can co-occur. Dodd et al. (2018) evaluated the speech errors of children at 4;0 and then again at 7;0 years old. The findings indicated that 14% of participants presented with co-occurring articulation and phonological errors (Dodd et al., 2018). These results are in line with the findings of the present study. Additionally, it was noted in Dodd et al.'s (2018) study that 8% of participants who presented with only phonological disorders or inconsistent phonological disorders at age 4;0 had acquired articulation errors by 7;0 years old. These articulation errors were recorded as distortions of alveolar fricatives /s, z/ (Dodd et al., 2018). One participant in the present study was 5;11 years (i.e., below 7;0) and presented with a co-occurring articulation disorder and phonological disorder. The remaining three of the four participants who presented with co-occurring SSDs were above 7;0 years. It could be that these participants acquired articulation errors coinciding with phonological or inconsistent phonological disorders that were present and went untreated when they were younger, as suggested by Dodd et al. (2018). However, this would have to be evaluated in greater detail in future research. The presentation of coinciding SSDs may impact an SLT's decisions regarding their approach to intervention, including which treatment approach to use and which SSD to target first.

5. 1. 2 The effect of age on the occurrence of SSDs

The results of the present study were not analysed according to participants' ages. However, the frequency and types of SSDs across different age groups are briefly discussed here to highlight some trends observed in the data. Figure 6 indicates the frequency of each SSD according to participants' ages.

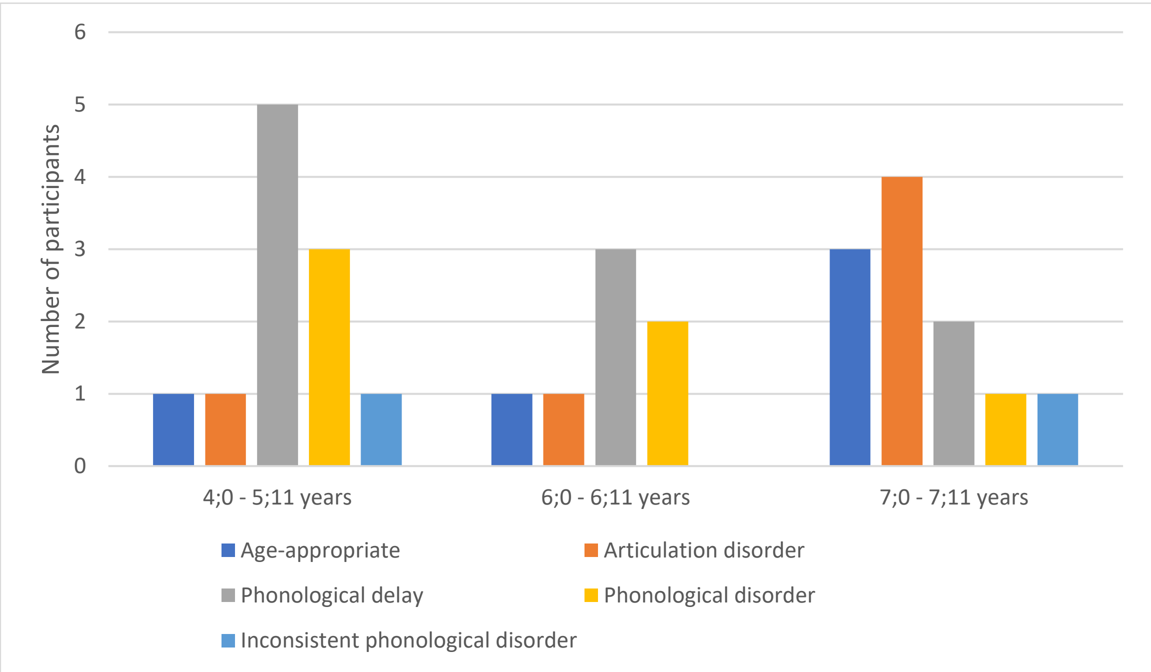

Figure 6. The frequency of each SSD across one-year age bands

A higher prevalence of age-appropriate speech was observed in older children. As expected, as children get older the number of errors in their speech decreases, which allows for the age-appropriacy of their speech to increase (Dodd et al., 2003; Pascoe et al., 2018). While this held true for phonological errors (delays, disorders, and inconsistent disorders), the occurrence of articulation disorders in the present study was observed more frequently in older children. The difference in the occurrence of articulation disorder in the present study compared to research conducted on typically developing children may suggest that children with ASD acquire phonemes at a slower rate than their typically developing peers. Additionally, since ASD is known to be a neurodevelopmental disorder, differences in acquisition of phonemes (which phonemes are acquired at which ages) between this population and typically developing children, is to be expected based on previous research in other developmental areas. For example, Tek, Mesite, Fein and Neigles (2014) conducted a study evaluating the language abilities of 18 typically developing children and 17 children with ASD. Their findings indicated that there is a wide array of differences in language development between children with ASD and their typically developing peers, as well as, between each individual child with ASD. Further research into the speech development in children with ASD is required in order for clinicians to better understand the types of developmental patterns and phoneme acquisition among children with ASD for improved service provision.

5. 1. 3 Intelligibility ratings and classification of SSDs

The ICS was completed by parents and/or legal guardians to gain an understanding of each participant's intelligibility in different environments. Results indicated that participants were most intelligible to familiar communication partners (i.e., parents and teachers). This was expected and these findings concur with information documented in previous literature (Flipsen, 1995; McLeod et al., 2012). When analysing the results obtained from the ICS, intelligibility trends in relation to the subtypes of SSDs were observed. Participants who presented with age-appropriate speech were reported to be the most intelligible across contexts by their parents and/or legal guardians. These results correlated with findings from previous literature which indicated that children with typically developing speech (i.e., age-appropriate speech) obtained the highest intelligibility ratings (Hodge & Gotzke, 2011). It was expected that participants with no speech errors or age-appropriate speech errors would be perceived as more intelligible by their parents and/or legal guardians as their speech development is following a typical developmental trajectory.

Second to age-appropriate speech, participants with phonological delays were noted to have received the highest intelligibility ratings. It is plausible that of the participants who presented with an SSD, those with phonological delays were most intelligible. This may be because delayed speech is still following typical development, but error patterns are those typical of a child who is younger (Dodd, 2014). Additionally, simplification errors noted in phonological delays often allow for production of words to closely resemble the target. Error patterns are also consistent, and children will present with the same error each time the same word is produced. Owing to this, higher ratings of intelligibility in children with phonological delays could be due to familiar listeners (parents, family members, teachers, and friends) having observed and learnt error patterns that are specific to the child. The data indicated that participants who presented with more phonological processes in their speech were reported as less intelligible to strangers and acquaintances. Previous studies have indicated that children who present with more phonological processes and/or more frequently occurring processes are likely to have reduced intelligibility (Petinou & Theodorou, 2019; Weston & Shriberg, 1992).

Participants who presented with an articulation disorder were the third most intelligible group, as rated using the ICS. Depending on the type of error, children with articulation disorders have been noted to be mostly intelligible (Kent, Miolo & Bloedel, 1994; Namasivayam et al., 2013). This could be because generally only one phoneme is affected. For example, children who present with a lisp may still be intelligible to both familiar and unfamiliar listeners (Kent et al., 1994). Additionally, familiar listeners could – in time – learn a child's articulation errors and understand their substitutions to understand them. Following articulation disorders, participants with phonological disorders were ranked fourth in intelligibility amongst the different types of SSDs. Participants with phonological disorders may have been reported as less intelligible than participants with phonological delays because their errors are non-developmental, making it more difficult for a mother-tongue speaker to perceive the patterns in their speech. Additionally, in phonological disorders, unusual error patterns may occur alongside delayed/developmental errors which may further impact intelligibility. The literature suggests that children with phonological disorders have limited intelligibility, even with a familiar communication partner (Weston & Shriberg, 1992). This may be because it is more challenging to observe error patterns in phonological disorders since phoneme simplifications do not closely resemble the target word.

The least intelligible group was noted to be those with inconsistent phonological disorders. Previous literature has indicated that children with inconsistent speech errors are unintelligible across contexts (i.e., with familiar and unfamiliar listeners) (McIntosh & Dodd, 2008). This was expected because inconsistent error patterns are not predictable which may impact a listener's ability to perceive which phonemes are being substituted and what those substitutions are.

5. 2 Production of consonants

The literature has indicated that children acquiring English, globally and in South Africa, appear to acquire all consonant phonemes apart from the dental fricatives /θ, ð/ by 5;11 years (Dodd et al., 2003; Pascoe et al., 2018). The present study found similar results in children with ASD. All participants had stops, nasals and glides present in their phonetic inventories. These results correlate with the literature on typically developing children, indicating that these phonemes are generally acquired by 3;5 years (Dodd et al., 2003; McLeod & Bleile, 2003). There was variation in the acquisition of fricatives, affricates, and liquids across the participant sample. The age-appropriacy of participants missing these phonemes are reflected in Figure 7 and discussed in-depth below.

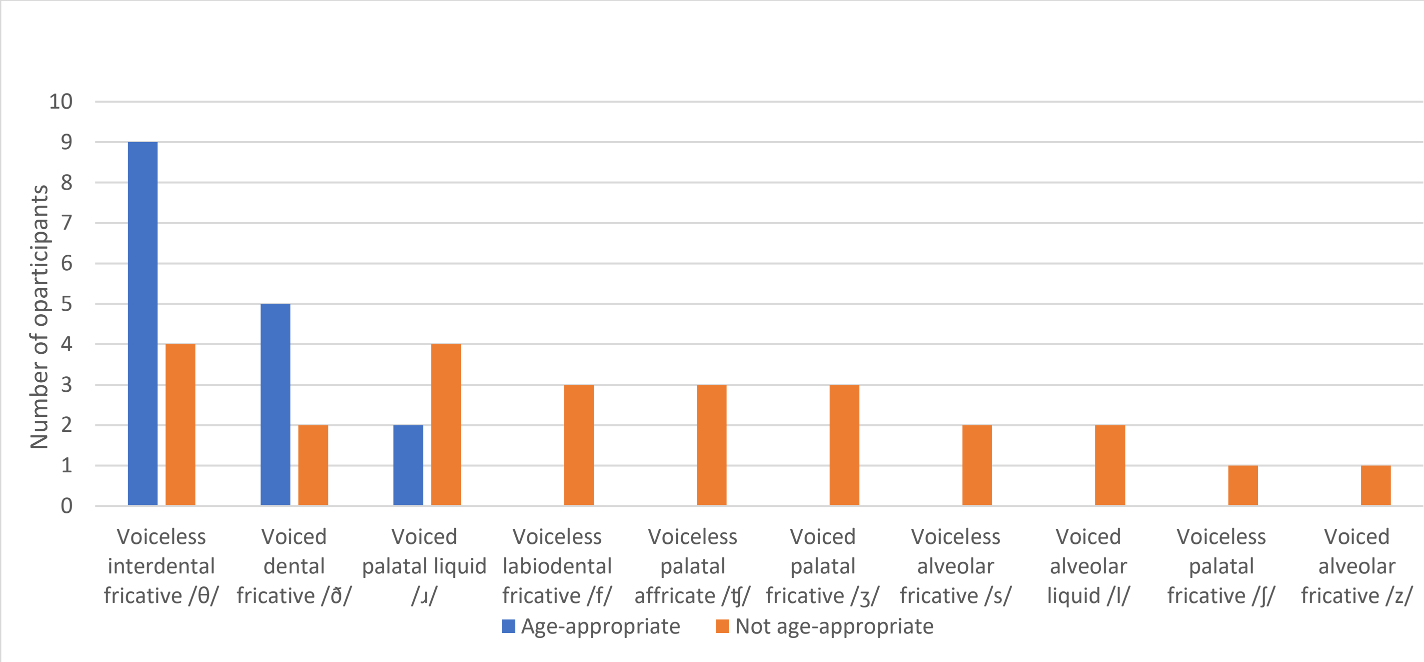

Figure 7. The age appropriacy of missing phonemes

5. 2. 1 Fricatives

Fricatives were noted to be the most challenging phoneme class among the participants in this study. Certain fricatives are reportedly later-developing in typically developing children acquiring English (Dodd et al., 2003; McLeod & Bleile, 2003; Pascoe et al., 2018). Voiceless interdental fricative /θ/ and voiced /ð/ had not been acquired by thirteen (52%) and seven (28%) participants, respectively, making them the two most commonly missing phonemes in this study sample. This was expected, as these phonemes have been recorded as later-developing sounds and were only expected to be present in the speech of participants who are 7;0 years and above (Dodd et al., 2003; McLeod & Bleile, 2003; Pascoe et al., 2018). Voiceless interdental fricative /θ/ was missing from the phonetic inventories of seven participants (28%) aged between 4;3 and 6;11 years, and a further six participants (24%) between 7;0 and 7;5 years. It was considered inappropriate for /θ/ to not have been acquired by the 6 participants who were above 7;0 years. All 7 participants (28%) who had not yet acquired voiced interdental /ð/ were aged between 4;3 and 6;1 years. Therefore, it was age-appropriate for these participants to not yet have acquired this phoneme. In this way, it appears as though children with ASD may acquire voiced interdental /ð/ at the same rate as typically developing children.

Voiceless labiodental fricative /f/, voiced palatal fricative /ʒ/, and voiceless alveolar fricative /s/ were all missing from the phonetic inventories of three different participants (12%). These phonemes are expected to be acquired between 3;5 – 4;0 years (Dodd et al., 2003; McLeod & Bleile, 2003; Pascoe et al., 2018). The participants who were not yet able to produce these phonemes were all over 5;0 years old, making it inappropriate for this phoneme to be missing from their phonetic inventories. These findings suggest that children with ASD acquire voiceless labiodental fricative /f/, voiced palatal fricative /ʒ/, and voiceless alveolar fricative /s/ at similar ages as their typically developing peers. While these phonemes had not yet been acquired by three participants (12%), the majority of participants in the sample (88%) had.

Lastly, voiceless palatal fricative /ʃ/ and voiced alveolar /z/ were missing from the inventories of 1 participant. The absence of voiceless palatal fricative /ʃ/ was considered age-appropriate, as this phoneme is expected to be acquired between 5;0 and 5;5 years in international dialects of English, and by 5;0 in South African English (SAE) (Dodd et al., 2003; McLeod & Bleile, 2003; Pascoe et al., 2018). The participant was 4;3 years old, and therefore, below the age range noted for acquisition. Hence, it appears that children with ASD acquire voiceless palatal fricative /ʃ/ within the same age range as children who are typically developing. It was recorded as inappropriate for voiced alveolar fricative /z/ to be missing, as the participant was 6;2 years old and this phoneme is typically acquired between 3;0 – 4;0 years (Dodd et al., 2003; McLeod & Bleile, 2003). Since this phoneme was only missing from the phonetic inventory of one participant (4%), it can be said that children in the sample – and perhaps children with ASD who generally communicate verbally – acquire voiced alveolar fricative /z/ at the same rate as their typically developing peers.

5. 2. 2 Affricates

All participants had voiced palatal affricate /ʤ/ in their phonetic inventories. These findings correlate with research on typically developing children, which has indicated that this phoneme is generally acquired between 4;0–4;5 years (Dodd et al., 2003; McLeod & Bleile, 2003; Pascoe et al., 2018). The second affricate sound, voiceless palatal /ʧ/ was missing from the phonetic inventories of 3 participants (12%), who were aged 5;0–6;8 years. Previous research on typically developing children has indicated that this phoneme is acquired between 4;0–4;5 years old, and by 3;5 years in SAE (Dodd et al., 2003; McLeod & Bleile, 2003; Pascoe et al., 2018). The acquisition of the voiceless palatal affricate /ʧ/ was therefore noted to be delayed when compared to the available data on typically developing children acquiring English. However, since most of the participants (88%) had this phoneme in their phonetic inventories it could be suggested that children with ASD acquire voiceless palatal affricate /ʧ/ within the same age range as what would be expected for typically developing children.

5. 2. 3 Liquids

The alveolar liquid /l/ has been noted to be acquired between 3;6–4;0 years old in typically developing children (Dodd et al., 2003; McLeod & Bleile, 2003). Two participants (8%) in the present study did not have /l/ in their phonetic inventories. Both participants were above 4;0 years old, making it inappropriate for them to have not yet acquired this phoneme. Secondly, the voiced palatal liquid /ɹ/ was missing from the phonetic inventories of five participants. they All replaced /ɹ/ with voiced bilabial glide /w/, and none of them were stimulable for correct production of this phoneme in syllables or in isolation. Voiced palatal /ɹ/ is anticipated to be acquired between 6;0–6;5 (Dodd et al., 2003; McLeod & Bleile, 2003). Two of the participants in this study were below this age range, and therefore, it was considered age-appropriate for them to not yet have the phoneme present in their phonetic inventories. However, the remaining three participants (12%) were between 6;10–7;7 years old. Similar to the acquisition of fricative and affricate phonemes, children with ASD appear to develop liquids at the same rate as their typically developing peers. Although, some participants were noted to be missing certain phonemes, the majority of participants in this study had acquired phonemes at the same age as is expected in children who are typically developing. This suggests a similarity in speech acquisition between typically developing children and those with ASD (particularly, those children who mainly communicate verbally).

5. 3 Production of vowels

The literature suggests that English-speaking children typically master all vowels between 2;0–3;0 years old (Dodd et al., 2003; Ko, 2007). This was true for twenty-three participants (92%) in the present study. Two participants (M04 and ECD4) were observed to each be missing one vowel from their phonetic inventories, namely high front vowel /ɪ/ (replaced by front open-mid /ɛ/) and mid central /ʌ/ (replaced by back /ɔ/). Each vowel was consistently substituted during single word naming tasks and in conversational speech. Participant M04 presented with a phonological delay and C04 with an articulation disorder co-occurring with a phonological delay. Difficulties with vowel sounds have been noted to be indicators of CAS (Shriberg et al., 2011). However, these two participants did not meet other criteria warranting a diagnosis of CAS, namely, inconsistent errors, oro-motor difficulties, and inappropriate prosody (Tierney et al., 2015; Morgan & Webster, 2018). Therefore, it is likely that these errors occurred in isolation.

5. 4 Phonotactic structures

Production of monosyllabic, bisyllabic and multisyllabic words was also evaluated. Participants were able to produce words of up to four syllables. Four syllable words of varying shapes were noted to still be developing across the study sample, namely: CCCVC (e.g., /splaʃ/), CCVCV (e.g., /spaɪdə/), CVCCVCC (e.g., /bɪskɪts/), and CCVCCVCCVC (/slɪpɹislaɪd/). Typically developing children have been recorded to accurately produce three or more syllables between 5;0 and 6;0 years (McLeod & Bleile, 2003). The findings in the present study indicate that children with ASD who do not have CAS and use spoken language as their primary modality of communication, appear to develop various phonotactic structures at the same age as their typically developing peers.

5. 5 Percentage of consonants, vowels and phonemes correct

PCC, PVC and PPC scores were calculated to determine the accuracy with which participants were able to produce phonemes. PVC scores were higher than PCC scores for all participants. All participants presented with PVC scores of 90% or above, approximating adult phonology. This was expected based on previous studies conducted with typically developing children in which the results reported consistently higher PVC scores (Dodd et al., 2003; Pascoe et al., 2018; Toohill, McLeod & McCormack, 2012;). Additionally, studies conducted with typically developing children have indicated that most English-speaking children master all vowels between 2;0 and 3;0 years (Dodd, 2003; Ko, 2007). Interestingly, participants with lower PVC scores, compared to the rest of the sample, presented with significantly lower PCC scores. These participants also obtained lower scores on the ICS, suggesting a connection between severity indices and how intelligible participants were perceived to be by their parents and/or legal guardians. Higher PCC scores were generally observed in older children in the study. This may be a result of the elimination of phonological processes as children get older, as well as older children generally presenting with more complete phonetic inventories and produce phonemes with greater accuracy.

Previous studies conducted with monolingual and multilingual typically developing children have reported similar findings (Dodd et al., 2003; Pascoe et al., 2018; Toohill et al., 2012). As expected, participants with no errors or age-appropriate speech errors were noted to have the highest scores. These participants obtained PVC scores of 100% and PCC scores above 90%, approximating adult phonology. Apart from age-appropriate speech, no correlations were noted between severity indices and the type of SSD participants presented with. Rather, severity indices were linked to the frequency of errors participants had (i.e., number of phonological processes and/or number of articulation errors). The higher the number of errors in a participant's speech, the lower their PCC score.

5. 6 Phonological processes

Phonological processes are predictable sound simplifications that children use as their speech is developing (Dodd et al., 2003; Franciscatto et al., 2021). Phonological processes include error patterns that cause changes in the syllable structure of words and substitution errors in which one phoneme is substituted for another (Dodd et al., 2003; Franciscatto et al., 2021). Delayed speech patterns are observed when phonological processes persist beyond the age at which they are anticipated to be eliminated from a child's speech (Dodd, 2005). Phonological disorders, on the other hand, refer to the presentation of atypical phonological processes in a child's speech (Dodd, 2005). Both typical syllable and substitution processes and atypical phonological processes were observed in the sample.

5. 6. 1 Syllable structure processes

Four types of error patterns affecting the syllable structure in words were seen in the current study. These included: final consonant deletion; weak syllable deletion; cluster reduction; and assimilation. Cluster reduction was the most commonly occurring phonological process which affected syllable structure. These results met expectations, as previous research conducted with typically developing children has indicated that cluster reduction is a prominent error pattern (Dodd et al., 2003). Additionally, Cleland et al. (2010) found that cluster reduction was a common error in the speech of children with ASD. The most common clusters that were reduced by participants in this study were those containing the voiceless alveolar fricative /s/ (i.e., /sp, st, sn, sk/). Second to cluster reduction, final consonant deletion was a syllable structure process noted across the sample. Final consonant deletion is typically eliminated before 2;0 years and, therefore, was recorded as an immature process for the participants in this study (Dodd et al., 2002). Interestingly, previous research conducted on children with ASD recorded final consonant deletion to be a common speech error in this population (Cleland et al., 2010).

Thirdly, weak syllable deletion was observed in the speech of the study participants. According to Dodd et al. (2002) weak syllable deletion is expected to be eliminated from a child's speech by 3;11 years, which made the process immature for all participants in the current study. Finally, assimilation processes such as consonant harmony were observed in the sample. This process was only recorded in the speech of one participant, making it less common through the sample. Consonant harmony was noted to be immature as the participant was above 3;9 years old, the age at which it is typically suppressed (Bowen, 1998). The findings of this study observed delayed elimination of syllable structure processes in children with ASD, compared to their typically developing peers. These results agree with previous literature, which has highlighted that children with ASD are more likely to present with phonological processes (such as cluster reduction, final consonant deletion, weak syllable deletion, and assimilation) beyond the age of suppression for typically developing children. This is understandable seeing that ASD is a neurodevelopmental disorder, and children with ASD may present with delayed development of speech.

5. 6. 2 Substitution processes

Across the sample, five different substitution error patterns were recorded, namely: stopping; gliding of liquids; fronting; voicing; and deaffrication. Stopping of fricatives was the most common phonological process in the study. Depending on the phonemes affected, this process is typically expected to be eliminated from a child's speech between 3;0–5;0 years (Bowen 1998; Dodd et al., 2002). Eighteen participants (72%) presented with stopping of fricatives in the present study. Of the eighteen, fifteen (60%) were between 5;0 and 7;11 years, and therefore, over the age at which the process is expected to be eliminated in typically developing children. The voiceless interdental fricative /θ/ and voiced /ð/ were the most stopped fricative consonant phonemes. The voiceless interdental /θ/ was substituted with voiceless alveolar stop /t/ consistently among all participants. Voiced /ð/ was consistently replaced by voiced alveolar stop /d/. These substitutions correlated with data in typically developing children (Holm et al., 1999). Second to stopping, gliding of liquids was the most common phonological process throughout the sample. Dodd et al. (2002) have noted that this error pattern is expected to be eliminated from a child's speech at 5;11 years. This made the phonological processes immature for seven participants (28%) and age-appropriate for eight (32%). Gliding has been previously recorded as a prevalent error pattern in typically developing children as well as in children with ASD (Cleland et al., 2010; Dodd et al., 2003). Additionally, previous studies conducted on children acquiring SAE have noted that gliding of liquids may persist beyond 5;11 years in monolingual and multilingual children (Pascoe et al., 2018). Third, fronting (velar and palatal) was noted across the sample. Velar fronting is said to be eliminated from a child's speech by 3;11 years and palatal fronting by 3;6 years (Bowen, 1998; Dodd et al., 2002). This made both velar and palatal fronting immature for all participants in the sample. Voicing and deaffrication errors were noted in the sample, however they were not as common as previously mentioned errors. Three participants (12%) presented with context sensitive voicing and the error was noted to be immature in all three as they were above 2;11 years – the age at which voicing errors are typically eliminated from a child's speech (Dodd et al. 2002). Only two participants (8%) presented with deaffrication. Deaffrication has been noted to be supressed by 4;11 years old (Dodd et al., 2002). Both participants were older than this, making the phonological process immature in their speech compared to their typically developing peers. Substitution errors in the sample were observed to persist beyond what is expected in typically developing children, suggesting that children with ASD are more likely to present with delayed error patterns later into childhood. These results correlate with the literature, which has noted children with ASD to present with delayed speech development patterns (Cleland et al., 2010). This can be expected seeing as ASD is classified as a developmental disorder, and delayed or unusual developmental patterns are predicted (Christensen & Muddler, 2020).

5. 6. 3 Atypical error patterns

Atypical error patterns refer to errors that are non-developmental and are not expected to be present in a child's speech, regardless of their age (Dodd et al., 2003; Dodd et al., 2014). Participants presented with the following atypical phonological processes: initial consonant deletion; medial consonant deletion; affrication; backing; and denasalisation. Initial consonant deletion, medial consonant deletion and affrication were observed in more than 10% of participants, making these errors more prevalent in the current sample than in data that has been recorded for typically developing children (Dodd et al., 2003). Therefore, it would seem that children with ASD are more likely to present with non-developmental error patterns. This claim is supported by previous research conducted on children with ASD, which noted a higher prevalence of atypical error patterns than what has been recorded for typically developing children (Cleland et al., 2010). It is logical that speech development in these children may not always follow the typical trajectory. This has been documented in previous studies which have evaluated language development in children with ASD, indicating wide arrays of differences in development between children with ASD and their typically developing peers, as well as, between each individual child with ASD (Tek et al., 2014).

5. 7 Oro-motor function

Oro-motor function was a relative strength across the participant sample in the present study, with most participants presenting with average DDK rates (68%), isolated movements (88%), and sequenced movements (76%). In the DDK subtest, participants were scored according to the accuracy with which they sequenced target phonemes, intelligibility, and fluency. Most participants obtained a perfect score in these three scoring criteria. Intelligibility appeared to be an area of strength in the DDK subtest across the sample. These findings reaffirm the information obtained in the ICS, in which most parents and/or legal guardians reported their children to be intelligible across a variety of contexts. The findings from the oro-motor function assessment indicate that children with ASD may develop oro-motor skills at the same age as their typically developing peers and that these children have adequate motor abilities required for speech production. If the CAS-ASD hypothesis is taken into account, these results may be due to the characteristics of the sample and if children with lower verbal language abilities were included in the study, more difficulties with oro-motor function may have been observed (Shriberg et al., 2011). Therefore, it is suggested that future research on speech development in children with ASD should include participants who do not use spoken language as their primary modality of communication.

5. 8 Clinical implications

The results of this study highlight the occurrence of SSDs in children with ASD and paves the way for future research into establishing further normative data on speech acquisition in children with ASD. It is well known that children with ASD do not usually follow the same developmental trajectory as their typically developing peers (Bradshaw, Schwichtenberg & Iverson, 2022). Research evaluating language development in this population has been a popular area of study. However, there is currently limited evidence available on the variation of speech development in children with ASD. Often the assessment and management of language is seen as a priority – in research and in clinical practice – since an SLT's long-term therapy goal is often to provide the child with the tools to express themselves using a modality available to the child. The results of the present study have indicated that SSDs are prevalent in children with ASD aged 4;0 – 7;11 years, with 80% (n=20) of participants having presented with an SSD. It is therefore suggested that assessment batteries bare this in mind, and that

SLTs look out for oro-motor, articulation and phonological errors in children with ASD, as is common practice for typically developing children. This is important as it is known that speech acts as the linking bridge between language and literacy, and speech difficulties can impact on how a child develops the phonological awareness skills needed for later literacy development (Loudermill et al., 2021). This is an important factor to consider, seeing as these children are school-aged and their speech difficulties should not hinder their academic performance. Furthermore, speech development is closely linked to language development (Loudermill et al., 2021). Furthermore, when taking into account Shriberg et al.'s (2011) CAS-ASD hypothesis, motor speech disorders may be the cause of hindered verbal language development in children with ASD. Emphasising the need for speech to be assessed and managed within this population, specifically in children who are minimally or non-verbal. In children with minimal verbal language, speech may be assessed using oro-motor assessments and observations of a child's oro-motor abilities in different contexts. The present study has indicated that for children with ASD who use verbal language, speech assessments that have been developed for a typically developing population, such as the DEAP (Dodd et al., 2002), can be used to measure their speech development.

In South Africa, a large portion of the population is multilingual (Pascoe et al., 2010). However, most SLTs speak English and/or Afrikaans, which often leads to language barriers between the SLT and the child (Pascoe & Norman, 2011). These challenges have been addressed by the International Expert Panel on Multilingual Children's Speech (2012), where guidelines are provided for SLTs. However, there are currently no guidelines available when SLTs are required to assess and manage children who speak a different language to them, in addition to having a neurodevelopmental disorder such as ASD. Research, such as the present study, which highlights speech development and the occurrence of difficulties, will assist in the development of future guidelines in this area. Guidelines may note factors regarding ways in which the phonology of a child's first language may influence production of speech sounds in other languages they acquire. For example, children acquiring Afrikaans as their first language may substitute voiceless interdental fricative /θ/ for voiceless labiodental fricative /f/ (e.g., 'tee**th**' /ti**θ**/ may be produced as [ti**f**]).

5. 8. 1 Recommendations for intervention

In this study, SSDs were classified according to Dodd's (2005) differential diagnostic framework, and therefore, it is recommended that an intervention approach is selected based on Dodd's (2005) recommendations as was described in Chapter 1, Section 1.4 of this thesis. Using Dodd's (2005) selection of intervention approaches, SLTs should consider any adaptations that may need to be made to intervention when working with children with ASD and being mindful of each child's language profile. Two intervention approaches have been highlighted, namely, a bilingual approach or a cross-linguistic approach (Goldstein & Gildersleeve-Neumann, 2015). Goldstein & Gildersleeve-Neumann (2015) suggest that both approaches may be relevant at different points throughout intervention. If intervention is being conducted in only one language, it is important for the SLT to clarify how the intervention strategies and targets relate to the child's other language(s) at the end of each session (Goldstein & Gildersleeve-Neumann, 2015). In addition to language profiles, SLTs should be mindful of any accommodations that need to be made during intervention when working with a neurodiverse population. It is recommended that SLTs make use of visual timetables and timers (e.g., a clock or sand-timers) so that children understand what is expected of them and how long they are expected to engage in a certain activity. Furthermore, it is suggested that time is schedules in between activities for sensory breaks that are tailored to the child's needs.

5. 9 Limitations and suggestions for future research

Several limitations have been noted and need to be considered when surveying the results. The limitations of the study include the sample size, language profiles, verbal language ability of participants, and assessment tools.

5. 9. 1 Sample size

The sample size was relatively small (25 participants), which impacts on the generalisability of the results. Furthermore, participants in the sample were not stratified based on age or gender and, therefore, results are not fully representative of all 4;0 – 7;11 year olds with ASD. There were 22 boys and just 3 girls who partook in the study. It has been previously recorded that ASD is more commonly diagnosed in males, and this may be the reason for more boys having been recruited in the current study (Hull et al., 2020; Volkmar et al., 2004). This may have skewed the results of the study, as it has also been documented that males may develop speech later or present with features of delayed speech for longer than what would be expected in their female counterparts (Dodd et al., 2003). With regards to age-group imbalances, the results of the present study may not be fully inclusive of younger children with ASD. There were ten participants who were 5;11 or younger, with only one participant aged below 5;0 years, and fifteen who were older than 5;11 years. The study was also conducted in a specific location (the Southern Suburbs of Cape Town, Western Cape) which again limits the generalisability of the findings. Thus, future research on the occurrence of SSDs in children with ASD should be conducted on a larger scale. Further, it may be helpful to stratify participants based on gender and age. Additionally, it is recommended that future research should diversify participants based on geographical location in South Africa.

5. 9. 2 Language profiles

Participants in the study were all acquiring English and attending schools where the language of learning and teaching (LoLT) is English. However, it is likely that most participants were bi/multilingual, given the demographics of South Africa (Pascoe at el., 2010). However, a complete language profile for each participant was not established during the research process. Thus, the results obtained using Dodd's (2005) differential diagnostic framework need to be interpreted with caution as children acquiring multiple languages may acquire phonology in a different order or rate compared to their monolingual peers (Holm, Dodd, Stow & Pert, 1999; Pascoe et al., 2018). Additionally, speech errors that may be marked as atypical in monolingual children could be observed as developmentally appropriate in bi/multilingual children (Holm et al., 1999; Pascoe et al., 2018). In this way, overdiagnoses of SSDs may occur in children acquiring more than one language. It is suggested that future research evaluating the occurrence of SSDs in children with ASD should obtain complete language profiles for each participant. Data could then be analysed according to whether participants are mono or bi/multilingual and in which languages.

5. 9. 3 Verbal language abilities

One of the objectives of the study was to determine the occurrence of CAS in children with ASD who present with an SSD. This objective was derived from the CAS-ASD hypothesis, which proposes that motor speech difficulties, namely CAS, are responsible for limited verbal language abilities in children with ASD (Shriberg et al., 2011). In order to assess the validity of the CAS-ASD hypothesis, children with ASD who are minimally verbal and/or non-verbal would need to be assessed. However, this brings about a challenge for researchers in obtaining a complete speech sample (something that could be adapted in the future) from a child who has limited and/or no verbal language. Due to the nature of the speech assessment, participants were required to communicate verbally to be included in the study. This may have impacted the types of SSDs found and the occurrence of more complex SSD, such as CAS. Additionally, participants in the current study were found to develop oro-motor skills at the same trajectory as their typically developing peers. If children with lower verbal language abilities had been included in the study, more differences in the oro-motor results may have been observed (Shriberg et al., 2011).

5. 9. 4 Assessment tools

The DEAP was used to assess the speech of all participants in the study. This assessment tool was selected as it is easy and relative quick to administer. Furthermore, the assessment tool covers all areas of speech (i.e., oro-motor, articulation, phonology and, inconsistency). However, although the DEAP is useful in classifying speech according to Dodd's (2005) differential diagnostic framework, it is limited when assessing motor speech. It is suggested that future research use additional assessment procedures/tools alongside the DEAP in order to further evaluate motor speech abilities of children with ASD. Assessment tools may include the Verbal Motor Production Assessment for Children (VMPAC) (Hayden & Square, 1999). The VMPAC has been noted as a valuable assessment tool in assessing vowel production and inconsistency and has been reported to be the gold standard assessment when diagnosing CAS (Sayahi & Jalaie, 2016).

5. 10 Summary

This chapter has explored the findings of the study in order to describe the occurrence of SSDs in children with ASD. The types of SSDs that participants presented with were described according to Dodd's (2005) differential diagnostic framework. It appeared that the occurrence of specific SSDs in children with ASD, within this sample, was in line with research conducted on typically developing children. This suggests that children with ASD with an SSD are likely to present with similar types of SSDs as their typically developing peers. Participants in the sample were able to produce all stops, nasals, and glides. Variation in the acquisition of fricatives, affricates, and liquids across the participant sample were noted and described. While, some participants presented with delayed acquisition of fricatives, affricates, and liquids, the trend across the sample suggested that children with ASD between 4;0 – 7;11 years, who use spoken language, develop speech at the same rate as their typically developing peers. Additionally, vowels and phonotactic structures appeared to develop within this population within similar age groups as indicated for typically developing children. Delayed phonological development was observed in the present study, with phonological error patterns persisting beyond the typical age of suppression for several participants. Additionally, higher occurrences of unusual phonological processes were noted in the sample, suggesting that children with ASD are more likely to present with atypical errors. The results of the study highlight the occurrence of SSDs in school aged children with ASD. Furthermore, the study attempted to bridge the gap that currently exists in the literature on speech development in children with ASD and to guide future research on this topic.

5. 11 Conclusion

The study aimed to describe the subtypes of SSDs in children with ASD aged 4;0 – 7;11 years. The study objectives were investigated using a comprehensive speech assessment. Research findings were analysed by means of independent and relational analyses. Descriptions were made based on the classifications of SSDs, intelligibility ratings, production of phonemes and phonotactic structures, the occurrence of phonological processes, oro-motor ability, and prosody. Findings indicated that phonological delays were the most commonly occurring SSD. None of the participants in the sample presented with CAS. This may be due to the study selection criteria, in which participants were required to have a certain level of verbal language abilities to take part in the study. Intelligibility ratings provided by participants' parents and/or legal guardians yielded results indicating that phonologically delayed speech is perceived as the most intelligible, while inconsistent speech was noted to be least intelligible. The findings suggested that children with ASD appear to acquire consonants at the same trajectory as typically developing children. Variations in the acquisition of fricatives, affricates and liquids were observed. Additionally, findings indicate that children with ASD acquire vowels within the same age group as their typically developing peers. Participants in the study developed various phonotactic structures at the same age as their typically developing peers. Phonological processes (substitution, syllable and atypical) were observed across the sample. Findings suggest that children with ASD are more likely to present with delayed and atypical phonological processes in comparison to typically developing children. Additionally, participants in the present study appeared to develop oro-motor skills within the same age range as their typically developing peers, with most participants achieving average range scores for DDK rates, isolated movements, and sequenced movement. The results of this study have indicated that while children with ASD acquire phonemes at the same rate as their typically developing peers, children with ASD may be more likely to present with SSDs. These findings highlight the need for SLTs to ensure that accurate speech assessments are carried out among this population, rather than focusing solely on language. This study is a starting point for further research to be carried out on speech development and SSDs in children with ASD and globally. Additionally, further larger-scale studies are required to better understand the prevalence of SSDs, and specifically CAS, in children with ASD.

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APPENDICES

Appendix A: Ethical clearance

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room G50- Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492
Email: hrec-enquiries@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

15 October 2021

HREC REF: 572/2021

Miss O Mahura
Department of Health & Rehab Sciences
F-45 OMB
Email: o.mahura@uct.ac.za
Student: kptste001@myuct.ac.za

Dear Miss Mahura

PROJECT TITLE: AN EXPLORATION OF THE OCCURRENCE OF SPEECH SOUND DISORDERS IN CHILDREN AGED 4;0-7;0 YEARS WITH AUTISM SPECTRUM DISORDER-MSC CANDIDATE-MISS STEFANIE KAPOUTSIS

Thank you for your response letter, addressing the issues by the Faculty of Health Sciences Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

This approval is subject to strict adherence to the HREC recommendations regarding research involving human participants during COVID -19, dated 17 March 2020; 06 July 2020 & 01 July 2021.

Approval is granted for one year until the 30 October 2022.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: Miss Stefanie Kapoutsis will also be involved in this study.

Please quote the HREC REF 572/2021 in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

HREC/REF 572/2021sa

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
NHREC-registration number: REC-210208-007

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC/REF 572/2021sa

Appendix B: Permission to conduct research from Department of Basic Education

Western Cape Government
Education

Directorate: Research

meshack.kanzi@westerncape.gov.za
Tel: +27 021 467 2350
Fax: 086 590 2282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20211022-6952
ENQUIRIES: Mr M Kanzi

Ms Stefania Kapoutsis
B2 Westerford Close
6 Mount Road
Rondebosch
7700

Dear Ms Stefania Kapoutsis,

RESEARCH PROPOSAL: AN EXPLORATION OF THE OCCURRENCE OF SPEECH SOUND DISORDERS IN CHILDREN AGED 4;0-7;0 YEARS WITH AUTISM SPECTRUM DISORDER.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **22 October 2021 till 31 April 2022.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Mr M Kanzi at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. The approval of your research request does not imply a promise of any data from the WCED. Should you require data, you will have to request it from the participating schools where it will be possible to secure parental consent.
11. Please note that POPIA prohibits the sharing of personal information without parental consent.
12. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
13. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.

Meshack Kanzi
Directorate: Research
DATE: 22 October 2021

1 North Wharf Square, 2 Lower Loop Street,
Foreshore, Cape Town 8001
tel: +27 21 467 2531

Private Bag X 9114, Cape Town, 8000
Safe Schools: 0800 45 46 47
wcedonline.westerncape.gov.za

Appendix C1: Information letter and permission request from the Western Cape Department of Basic Education

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Department of Health and Rehabilitation Sciences
Divisions of Communication Sciences and Disorders,
Nursing and Midwifery, Occupational Therapy, Physiotherapy
F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W/Cape, 7925
Tel: 021 406 6401/ 6428/ 6628/6534
Fax: 021 406 6323

Re: Research study description and request for permission to conduct research at schools in the Western Cape.

Dear Sir/Madam

I am a Speech-Language Therapist enrolled in the Master of Science in Speech-Language Pathology Programme at the University of Cape Town. In order to meet the requirements of my degree I am required to conduct a research study. The study I wish to conduct aims to describe the speech sound skills of children with Autism Spectrum Disorder between four and seven years old.

There is very little information available regarding the speech characteristics and the type of speech sound disorders that children with Autism Spectrum Disorder may present with. Therefore, information obtained from this study will be helpful to Speech-Language Therapists and other health and education professionals in better assessing and managing children with Autism Spectrum Disorder. The study will be conducted between September and December 2021. Fifty children between the ages of four and seven who have received a diagnosis of Autism Spectrum Disorder will be included in the study. Participants will also be required to have an adequate language comprehension. It will involve a language assessment, a speech sound assessment, as well as, gathering case history information from both caregivers and educators. The language speech assessment will be conducted using the Diagnostic Evaluation of Articulation and Phonology (DEAP). The DEAP is a standardised assessment tool consisting of four subtests. The subtests will require learners to label pictures of everyday objects, as well as, describe what they see in some of the picture cards. This will allow the researcher to evaluate the sounds the learners produce in words and phrases. Learners' responses during the assessment will be recorded using a voice-recorder.

I have received permission from the University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee (____________________________). This letter therefore serves as a request for permission from the Western Cape Department of Basic Education to conduct my research study in schools in the Cape Town area. Additionally, I request information and contact details of the schools who are for learners with Autism Spectrum Disorder with English as their language of learning and teaching. Only once I have received permission from the Department of Basic Education will I contact the schools to ask for permission to conduct research from the principals and then teachers. Once the principals of the schools have granted me permission, the caregivers of the identified learners will be contacted and they will be asked to provide their informed consent.

Arrangements will be made with the staff members of the selected schools for suitable times for the me to conduct the assessments. Each child will be assessed individually over two sessions, with each session lasting between 45 and 60 minutes. Assessments will be conducted on school premises. After the assessments, a summary of assessment findings will be shared with the child's caregiver and children who are identified with speech difficulties will be referred for speech therapy services, if they are not already receiving these services.

All ethical guidelines will be followed throughout the research process. Learners taking part in the study will do so voluntarily, and only after informed consent has been obtained from their caregivers. Participants will be able to withdraw from the study at any time, without having to provide a reason. Confidentiality will be maintained during and after the research study. All learners will be assigned a code to ensure that their names are not used when analysing voice recordings and reporting results. Only the myself (the researcher) and my supervisor will have access to the recordings. There will be no risks for the participants, their caregivers or the schools. There will be no monetary reward for participating in the research study.

Please note, COVID-19 precautions will be put in place during the assessment. I (the researcher) will wear a mask, covering both nose and mouth, through the assessment. Additionally, participants who are able to wear face masks will be encouraged to do so. The assessment room and all assessment tools will be sanitised after each participant. Hands (both my own and the participants') will be sanitised at the beginning and end of each assessment.

This letter serves as a request for permission to conduct my research study at schools in the Cape Town district.

Yours sincerely,

Stefania Kapoutsis	Olebeng Mahura
(Researcher)	(Research supervisor)
Tel: 073 158 7842	Tel: (021) 406 6528
Email: skapoutsis@gmail.com	Email: o.mahura@uct.ac.za

You may contact Professor Marc Blockman, Chairperson of the Human Research Ethics Committee of the Faculty of Health Sciences on 021 406 6346 if you have any queries about your rights and welfare as a participant in this study.

Appendix C2: Permission from the Western Cape Department of Basic Education

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Department of Health and Rehabilitation Sciences
Divisions of Communication Sciences and Disorders,
Nursing and Midwifery, Occupational Therapy, Physioth
F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W/Cape, 7925
Tel: 021 406 6401/ 6428/ 6628/6534
Fax: 021 406 6323

Re: Permission to conduct research at schools in the Western Cape

I,__________________________(name and surname), ____________________________ (position at the Western Cape Department of Education), grant permission for the research study to be conducted at schools in the Western Cape. The aims of the study, and the methods of how the study will be conducted have been explained to me. It has been brought to my attention that as part of the study, the researcher will ask the Department of Education for information about the schools in the area in order for schools to be correctly identified. I understand that the principals of the selected schools will be contacted by the researcher and asked for permission for the study to be conducted at their schools. I understand that once learners at the schools have been identified caregivers will be asked to provide their informed consent to have their children participate in the study. I understand that participants will be kept confidential during and after the research study. I also understand that participation in the study is voluntary and that participants may withdraw from the study at any time, without consequence or requiring an explanation.

Yours Sincerely,

Stefania Kapoutsis
(Researcher)
Tel: 073 158 7842
Email: skapoutsis@gmail.com

Olebeng Mahura
(Research supervisor)
Tel: (021) 406 6528
Email: o.mahura@uct.ac.za

You may contact Professor Marc Blockman, Chairperson of the Human Research Ethics Committee of the Faculty of Health Sciences on 021 406 6346 if you have any queries about your rights and welfare as a participant in this study.

Appendix D1: Information letter to Principals of schools

Faculty of Health Sciences
Department of Health and Rehabilitation Sciences
Divisions of Communication Sciences and Disorders,
Nursing and Midwifery, Occupational Therapy, Physiot
F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W/Cape, 7925
Tel: 021 406 6401/ 6428/ 6628/6534
Fax: 021 406 6323

Re: Information and request to conduct research at your school

Dear Sir/Madam

I am a Speech-Language Therapist enrolled in the Master of Science in Speech-Language Pathology Programme at the University of Cape Town. In order to meet the requirements of my degree I am required to conduct a research study. The study I wish to conduct aims to describe the speech sound skills of children with Autism Spectrum Disorder between four and seven years old, as well as, the characteristics of any speech sound disorders that children may present with.

There is very little information available regarding the speech characteristics and speech disorders that children with Autism Spectrum Disorder present with. Therefore, information obtained in this study will be helpful to Speech-Language Therapists, as well as, other health and education professionals in better assessing and managing children with Autism Spectrum Disorder. The study will be conducted between September and December 2021. Fifty children between the ages of four and seven who have received a diagnosis of Autism Spectrum Disorder will be included in the study. Participants will also be required to have an adequate language comprehension. It will involve a language assessment, a speech sound assessment and gathering case history information from both caregivers and educators. The speech assessment will be conducted using the Diagnostic Evaluation of Articulation and Phonology (DEAP). The DEAP is a standardised assessment tool consisting of four subtests. The subtests will require learners to label pictures of everyday objects, as well as provide describe what they see in some of the picture cards. This will allow the researcher to evaluate the sounds the learners make when speaking in single-word utterances and in phrases. Learners' responses during the assessment will be recorded using a voice-recorder.

Learners will be selected as participants of the study only once permission has been granted by you (the principal of the school), the educators and the caregivers. Learners who are able to give their verbal assent will be given the opportunity to do so. Arrangements will be made with you and the educators for suitable times for data collection. The children will be assessed individually over two sessions with each session lasting between 45 and 60 minutes. Assessment will be conducted on school premises. After the assessments, a summary of the assessment findings will be shared with the child's parents and children who are identified with speech difficulties will be referred for speech therapy services, if they aren't receiving them already.

All ethical guidelines will be followed throughout the research process. Learners taking part in the study will do so voluntarily, and only after informed consent has been obtained from their caregivers. Participants will be able to withdraw from the study at any time, without having to provide a reason. Confidentiality will be maintained during and after the research study. All learners will be assigned a code to ensure that their names are not used when analysing voice recordings and reporting results. Only the myself (the researcher) and my supervisor will have access to the recordings. There will be no risks for the participants, their caregivers or the schools. There will be no monetary benefits for taking part in the research study.

Please note, COVID-19 precautions will be put in place during the assessment. I (the researcher) will wear a mask, covering both nose and mouth, through the assessment. Additionally, participants who are able to wear face masks will be encouraged to do so. The assessment room and all assessment tools will be sanitised after each participant. Hands (both my own and the participants') will be sanitised at the beginning and end of each assessment.

This letter serves as a request for permission to conduct my research study at your school.

Yours sincerely,

Stefania Kapoutsis
(Researcher)
Tel: 073 158 7842
Email: skapoutsis@gmail.com

Olebeng Mahura
(Research supervisor)
Tel: (021) 406 6528
Email: o.mahura@uct.ac.za

You may contact Professor Marc Blockman, Chairperson of the Human Research Ethics Committee of the Faculty of Health Sciences on 021 406 6346 if you have any queries about your rights and welfare as a participant in this study.

Appendix D2: Permission from the Principal of the school

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Department of Health and Rehabilitation Sciences
Divisions of Communication Sciences and Disorders,
Nursing and Midwifery, Occupational Therapy, Physio
F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W/Cape, 7925
Tel: 021 406 6401/ 6428/ 6628/6534
Fax: 021 406 6323

Re: Permission to conduct research at____________________ School

I, ____ (name and surname), grant my permission for the research study to be conducted at _______________________ School. The aims of the study, and the methods of how the study will be conducted have been explained to me. I understand that the educators will be asked to assist the researcher by providing case history information and answering questions regarding the learners' learning patterns and behaviour. I understand that the study will involve a speech sound assessment that will be conducted at ___________________ School in a quiet place.

I understand that participants will be kept confidential during and after the research study. I also understand that participation in the study is voluntary and that participants may withdraw from the study at any time, without consequence or requiring an explanation.

______________________________ (name)

______________________________ (signature)

Yours Sincerely

Stefania Kapoutsis
(Researcher)
Tel: 073 158 7842
Email: skapoutsis@gmail.com

Olebeng Mahura
(Research supervisor)
Tel: (021) 406 6528
Email: o.mahura@uct.ac.za

You may contact Professor Marc Blockman, Chairperson of the Human Research Ethics Committee of the Faculty of Health Sciences on 021 406 6346 if you have any queries about your rights and welfare as a participant in this study.

Appendix E1: Information letter to the Educators

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Department of Health and Rehabilitation Sciences
Divisions of Communication Sciences and Disorders,
Nursing and Midwifery, Occupational Therapy, Physiotherapy
F45 Old Main Building, Groote Schuur Hospital
Observatory, Cape Town, W/Cape, 7925
Tel: 021 406 6401/ 6428/ 6628/6534
Fax: 021 406 6323

Re: Information pertaining to the research study and a request for permission for your assistance with information of learners taking part in the study.

Dear Sir/Madam

I am a Speech-Language Therapist enrolled in the Master of Science in Speech-Language Pathology Programme at the University of Cape Town. In order to meet the requirements of my degree I am required to conduct a research study. The study I wish to conduct aims to describe the speech sound skills of children with Autism Spectrum Disorder between four and seven years old, as well as, the characteristics of any speech sound disorders children may present with.

There is very little information available regarding the speech characteristics and speech disorders that children with Autism Spectrum Disorder present with. Therefore, information obtained in this study will be helpful to Speech-Language Therapists, as well as, other health and education professionals in better assessing and managing children with Autism Spectrum Disorder. The study will be conducted between September and December 2021. Fifty children between the ages of four and seven who have received a diagnosis of Autism Spectrum Disorder will be included in the study. Participants will also be required to have an adequate language comprehension. It will involve a speech sound assessment, as well as, gathering case history information from both the caregiver and you, the educator. The speech assessment will be conducted using the Diagnostic Evaluation of Articulation and Phonology (DEAP). The DEAP is a standardised assessment tool consisting of four subtests. The subtests will require learners to label pictures of everyday objects, as well as provide describe what they see in some of the picture cards. This will allow the researcher to evaluate the sounds the learners make when speaking in single-word utterances and in phrases. Learners' responses during the assessment will be recorded using a voice-recorder.

Learners will only be able to participate in the study once permission has been granted by the principal, yourself (the educator) and the caregivers. Learners who are able to give their verbal assent will be given the opportunity to do so. I request your assistance in identifying learners who meet the study criteria. I will then contact the caregivers of the learners who you will identify as possible candidates for the study with information pertaining to the aims of the study. Caregivers will be asked to sign a consent form should they be willing to have their children participate in the study. Once consent has been obtained from the learners' caregivers, you will be asked to provide information related to the learners' behaviour and learning patterns.

Arrangements will be made with you for suitable times for data collection. Please note, I will make an effort to ensure that your schedule is not disrupted. The children will be assessed individually over two sessions, with each session lasting between 45 and 60 minutes. Assessment will take place on school premises. Children will be provided breaks during the assessment as required. After the assessments, a summary of assessment findings will be shared with the child's caregiver and children who are identified with speech difficulties will be referred for speech therapy services, if they are not receiving them already.

All ethical guidelines will be followed throughout the research process. Learners taking part in the study will do so voluntarily, and only after informed consent has been obtained from their caregivers. Participants will be able to withdraw from the study at any time, without having to provide a reason. Confidentiality will be maintained during and after the research study. All learners will be assigned a code to ensure that their names are not used when analysing voice recordings and reporting results. Only the myself (the researcher) and my supervisor will have access to the recordings. There will be no risks for the participants, their caregivers or the schools. There will be no monetary benefit for taking part in the study.

Please note, COVID-19 precautions will be put in place during the assessment. I (the researcher) will wear a mask, covering both nose and mouth, through the assessment. Additionally, participants who are able to wear face masks will be encouraged to do so. The assessment room and all assessment tools will be sanitised after each participant. Hands (both my own and the participants') will be sanitised at the beginning and end of each assessment.

This letter serves as a request for your assistance in identifying suitable learners to take part in the study. Additionally, I request your permission for the identified learners to be assessed. Please note, you are free to contact me with any questions.

Yours Sincerely,

Stefania Kapoutsis
(Researcher)
Tel: 073 158 7842
Email: skapoutsis@gmail.com

Olebeng Mahura
(Research supervisor)
Tel: (021) 406 6528
Email: o.mahura@uct.ac.za

You may contact Professor Marc Blockman, Chairperson of the Human Research Ethics Committee of the Faculty of Health Sciences on 021 406 6346 if you have any queries about your rights and welfare as a participant in this study.

Appendix E2: Permission request from the educators

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Re: Permission to assist the researcher in identifying learners for the research study.

I, ____ (name and surname), agree to assist the researcher in identifying learners to take part in the research study. The aims of the study, and the methods of how the study will be conducted have been explained to me. I understand that the I, the educator, will be asked questions pertaining to the learners' case history information, their learning patterns and behaviour.

I understand that participants will be kept confidential during and after the research study. I also understand that participation in the study is voluntary and that participants may withdraw from the study at any time, without consequence or requiring an explanation.

________________________________ (name and surname)

________________________________ (signature)

Should you have any questions please feel free to contact myself or my supervisor.

Yours Sincerely

Stefania Kapoutsis	Olebeng Mahura
(Researcher)	(Research supervisor)
Tel: 073 158 7842	Tel: (021) 406 6528
Email: skapoutsis@gmail.com	Email: o.mahura@uct.ac.za

You may contact Professor Marc Blockman, Chairperson of the Human Research Ethics Committee of the Faculty of Health Sciences on 021 406 6346 if you have any queries about your rights and welfare as a participant in this study.

Appendix F1: Information letter to parents and/or legal guardians

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Observatory, Cape Town, W/Cape, 7925
Tel: 021 406 6401/ 6428/ 6628/6534
Fax: 021 406 6323

<u>Re: Information pertaining to the research study and a request for your permission for your child to participate.</u>

Dear Sir/Madam

I am a Speech-Language Therapist enrolled in the Master of Science in Speech-Language Pathology Programme at the University of Cape Town. In order to meet the requirements of my degree I am required to conduct a research study. The study I wish to conduct aims to describe the speech sound skills of children with Autism Spectrum Disorder between four and seven years old, as well as, the characteristics of any speech sound disorders children may present with.

There is very little information available regarding the speech characteristics and speech disorders that children with Autism Spectrum Disorder present with. Therefore, information obtained in this study will be helpful to Speech-Language Therapists and other health and education professionals in better assessing and managing children with Autism Spectrum Disorder. Fifty children will be required for the purposes of this study, and your child has been selected because they have received a diagnosis of Autism Spectrum Disorder, are between the ages of four and seven, and have a good understanding of words and language.

The research study will include a language assessment, a speech sound assessment, as well as, obtaining case history information from yourself (the child's caregiver) and their educator. The assessment will evaluate how your child produces sounds and words. The speech assessment will be conducted using the Diagnostic Evaluation of Articulation and Phonology (DEAP). The DEAP is a standardised assessment tool consisting of four subtests. The subtests will require learners to label pictures of everyday objects, as well as provide describe what they see in some of the picture cards. This will allow the researcher to evaluate the sounds the learners make when speaking in single-word utterances and in phrases.

As part of the assessment, educators will be asked to provide information about your child's behaviour and learning patterns in the classroom. You, as the child's caregiver, will also be asked to complete two forms. The forms are easy to complete and will provide me with information about your child's developmental history and how well you child is understood by you and others. This will all only be done after you have given your permission for your child to participate in the study. Your child will be assessed individually over two sessions, with each session lasting between 45 and 60 minutes. Your child will be given breaks as required. The assessment will be conducted in a quiet space on the school premises. I will make an effort to establish a relationship with your child before the assessment to ensure that your child feels comfortable. Please note, that after you have given your permission, your child will also be asked whether he/she would like to participate. If your child says that he/she would not like to participate, their decision will be respected.

The assessments will be recorded using a voice recorder. This is done so that I am able to listen to recording later and analyse your child's speech. Please note, that you and your child's names will be kept confidential throughout the process and once the results have been reported. Voice recordings will be stored securely and only myself (the researcher) and my supervisors will have access to the recordings.

You will be able to withdraw your child from the study at any time, without having to provide a reason. If the assessment findings suggest that your child has a speech difficulty, I will inform you on my findings and refer your child to a Speech Therapists, should you wish to take them to see one. There are no risks for you or your child in this research study. There will be no monetary reward if your child participates in the study.

Please note, COVID-19 precautions will be put in place during the assessment. I (the researcher) will wear a mask, covering both nose and mouth, through the assessment. Additionally, your child will be encouraged to wear a face mask if they are able to do so. The assessment room and all assessment tools will be sanitised after each child. My hands, and your child's hands, will be sanitised at the beginning and end of each assessment.

I have attached a consent form to this letter. Please sign the consent form and return the form to the child's educator should you wish for your child to participate in the study. Please note, you are free to contact me with any questions.

Yours Sincerely,

Stefania Kapoutsis	Olebeng Mahura
(Researcher)	(Research supervisor)
Tel: 073 158 7842	Tel: (021) 406 6528
Email: skapoutsis@gmail.com	Email: o.mahura@uct.ac.za

You may contact Professor Marc Blockman, Chairperson of the Human Research Ethics Committee of the Faculty of Health Sciences on 021 406 6346 if you have any queries about your rights and welfare as a participant in this study.

Appendix F2: Consent form for parents and/or legal guardians

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Fax: 021 406 6323

Re: Permission for your child to participate in the research study.

I, ____ (your name and surname), give my permission for my child _______________________________________ (child's name and surname) to participate in the research study.

The aims and study procedure have been explained to me. I understand the study will include a speech sound assessment, which will assess how my child speaks. I understand my child's educator will provide information related to his/her behaviour and learning patterns. I understand that my child's identity will be kept confidential during and after the research study. I understand that my child's participation in the research study and that I may withdraw my child from the study at any time without having to give an explanation.

______________________________ ______________________________

(Name) (Signature)

Should you have any questions please don't hesitate to contact me or my supervisor.

Yours sincerely,

Stefania Kapoutsis	Olebeng Mahura
(Researcher)	(Research supervisor)
Tel: 073 158 7842	Tel: (021) 406 6528
Email: skapoutsis@gmail.com	Email: o.mahura@uct.ac.za

You may contact Professor Marc Blockman, Chairperson of the Human Research Ethics Committee of the Faculty of Health Sciences on 021 406 6346 if you have any queries about your rights and welfare as a participant in this study.

Appendix G: Informed verbal assent from participants

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Fax: 021 406 6323

Re: Invitation to take part in study.

Dear ______________________ (learner's name)

My name is Stefania Kapoutsis. I am trying to find out how children like you speak. I want to understand how to help children who find it difficult to say words. If you want to take part, I will show you pictures and toys and you can tell me what you see. Your mom and dad said that you can play with me. It is okay if you do not want to play with me, nobody will be upset with you. You can tell me when you are tired, and we can take a break. You will only have to play with me and look at the pictures today.

Informed assent from the participants

I agree to take part in Stefania's study. She has told me what I have to do. I know that I can change my mind if I want to.

Participant Code : _______________

Name of researcher : _______________

Date : _______________

Appendix H: Case History Form

Child's name: ___________________________

Date of Birth: ___________________________

Pregnancy and Birth History

Were there any complications during pregnancy or birth? If yes, please explain.

____

____

____

How was the mother's health like during pregnancy (e.g. medication, illness, smoking)?

____

____

____

Medical History

Is your child generally healthy?

____

____

____

Does your child appear to have good hearing and eyesight? If no, please explain.

____

____

____

Is your child currently taking any medication? If yes, please state the medication.

____

____

____

At what age did your child receive the diagnosis of Autism Spectrum Disorder?

____

____

____

Has your child attended speech therapy or any other type of therapy in the past?

____

____

____

Developmental History

At what age was your child able to do the following:

Sit: ______________________

Crawl: _____________________

Walk: ______________________

Fist word: __________________________

Speech and Language skills

How does your child communicate with you or other people? (E.g. sentences, short phrases, using single words, gesture, pictures)

____

____

____

How well does your child understand you? (E.g. during a conversation or when you give instructions)

____

____

____

How well do you and other people understand your child's speech? Please explain.

____

____

____

Appendix I: Intelligibility in Context Scale

Intelligibility in Context Scale (ICS)

(McLeod, Harrison, & McCormack, 2012)

Child's name:______________________________

Child's date of birth:________________ Male/Female:________________

Language(s) spoken:______________________________

Current date: ________________ Child's age:________________

Person completing the ICS:______________________________

Relationship to child:______________________________

The following questions are about how much of your child's speech is understood by different people. Please think about your child's speech over the past month when answering each question. Circle one number for each question.

	Always	Usually	Sometimes	Rarely	Never
1. Do **you** understand your child[1]?	5	4	3	2	1
2. Do **immediate members of your family** understand your child?	5	4	3	2	1
3. Do **extended members of your family** understand your child?	5	4	3	2	1
4. Do your **child's friends** understand your child?	5	4	3	2	1
5. Do other **acquaintances** understand your child?	5	4	3	2	1
6. Do your **child's teachers** understand your child?	5	4	3	2	1
7. Do **strangers**[2] understand your child?	5	4	3	2	1
TOTAL SCORE =	/35				
AVERAGE TOTAL SCORE =	**/5**				

[1] This measure may be able to be adapted for adults' speech, by substituting *child* with *spouse*.
[2] The term *strangers* may be changed to *unfamiliar people*

Further information: McLeod, S., Harrison, L. J., & McCormack, J. (2012). The Intelligibility in Context Scale: Validity and reliability of a subjective rating measure. *Journal of Speech, Language, and Hearing Research, 55*(2), 648-656. http://jslhr.asha.org/cgi/content/abstract/55/2/648

McLeod, S., Harrison, L. J., & McCormack, J. (2012). *Intelligibility in Context Scale*. Bathurst, NSW, Australia: Charles Sturt University.
Retrieved from http://www.csu.edu.au/research/multilingual-speech/ics. Published November 2012.

Appendix J: Short questionnaire for educators

Learner's name: ____________________________________

1. Does the learner understand verbal instructions given in the classroom? If not, please describe what kind of compensatory strategies he/she requires (e.g., repeated instructions, visual demonstrations, etc.).

    ____

    ____

    ____

2. Is the learner able to identify and label objects in the classroom?

    ____

    ____

    ____

3. Does the learner understand new concepts that are taught well? Please explain.

    ____

    ____

    ____

4. Do you understand the learner when they are trying to communicate with you? If not, what in their speech do you find difficult to understand?

    ____

    ____

    ____

5. How does the learner interact with other children in the class?

    ____

    ____

    ____

6. What activities/toys does the learner have an interest in?

____

____

____

7. Are there any other general comments that you would like to add?

____

____

____

Appendix K: Visual schedule

1		Hello
2		Pictures
3		Bubbles or cars
4		Pictures
5		Bubbles or cars
6		Finished