Phonological and Morphological Interventions for Children with Co-Occurring Speech and Language Disorder: A Feasibility Single Case Study

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Whakataukī (Māori proverb)

Ehara taku toa i te toa takitahi, engari kē he toa takitini.

My success should not be bestowed onto me alone, it was not individual success but the success of a collective.

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Abstract

Purpose: This study aimed to investigate whether a morpho-phonological intervention that used phonologically and morphologically complex target words targeted in a combination of speech and language intervention strategies resulted in improvements in speech and language measures for a child with co-occurring speech and language difficulties. The study also aimed to investigate the intervention's feasibility and whether the approach lent itself to clinician-friendly administration.

Method: The study utilised a single-case design. The participant was aged four years eleven months and presented with a mild phonological disorder and queried diagnosis of developmental language disorder as measured by the Diagnostic Evaluation of Articulation and Phonology (DEAP) and Clinical Evaluation of Language Fundamentals-Preschool 2 (CELF-P2). At the beginning of the study, the participant could not mark past tense –ed and third-person singular –s words or produce word-final /v/ and word-final /sh/. The participant received 13 intervention sessions that targeted his productions of past tense –ed in words that ended in word-final consonants or cluster /sht/, and third-person singular –s in word-final consonants or cluster /vz/ through minimal pairs, focused language stimulation, and shared story interventions. The researcher conducted a subjective feasibility analysis.

Results: The participant improved his ability to mark third person singular –s but had no change in his ability to mark past tense –ed. The participant improved his ability to produce /sht/ in word imitations and spontaneous phrases but had variable results for his productions of /sht/ in spontaneous words and all productions of /vz/. The researcher identified facilitators and barriers to the intervention project's administration and provided suggestions for improving future studies' intervention procedures.

Conclusion: This was the first study investigating the effectiveness of selecting morphologically and phonologically complex target words and administering them in a morpho-phonological intervention within the same session. This was also the first feasibility study of a morpho-phonological intervention for children with co-occurring speech and language difficulties. The results show promise that morpho-phonological intervention methods could improve the speech and language abilities in children with co-occurring speech and language difficulties

Contents

List of Abbreviations and Terms

- 3S: Third-person singular –s
- ASHA: American Speech Language Hearing Association
- CATALISE: Criteria and Terminology Applied to Language Impairments: Synthesising the Evidence
- CDPD: Consistent deviant phonological disorder
- CELF-P2: Clinical Evaluation of Language Fundamentals – Preschool 2
- DEAP: Diagnostic Evaluation of Articulation and Phonology
- DLD: Developmental language disorder
- DR: Dialogic reading strategies
- EOWPVT-4: Expressive One-Word Picture Vocabulary Test-4
- FCD: Final consonant deletion
- FLS: Focused language stimulation
- GLS: General language stimulation
- ICD: Initial consonant deletion
- ICPD: Inconsistent deviant phonological disorder
- ILS: Indirect language strategies
- Kaiārahi: A person who guides, counsels, and leads others, especially in fostering relationships with Māori communities.
- LLI: Language learning impairment
- MLU: Mean length of utterance
- MMP: Meaningful minimal pairs

- MOE: Ministry of Education
- NWR: Non-word repetition
- NZAT: New Zealand Articulation Test
- PA: Phonological awareness
- Pākehā: New Zealand European
- PCC: Percent consonants correct
- PPC: Percent phonemes correct
- PPMP: Perception production minimal pairs
- PSTM: Phonological short term memory
- PVC: Percent vowels correct
- RAs: Research assistants
- RCT: Randomised Controlled Trial
- SCD: Single-case experimental design
- SLI: Specific language impairment
- SLT/SLP: Speech-language therapist/pathologist
- SSD: Speech sound disorder
- TD: Typically developing
- Te Reo Māori: The language of the Māori people of New Zealand
- TEGI: Test of Expressive Grammar
- WFC: Word final cluster
- Whānau: Te Reo Māori for the wide concept of immediate and extended family, caregivers, and community

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Introduction

Background

The acquisition of speech sounds and language occurs through natural means. Children possess an innate capacity to watch, listen to and learn from the speech and language information around them and exhibit a strong interest in engaging with communication (both verbal and non-verbal) (Rowland, 2013). Without direct instruction, typically developing (TD) children practise these emerging communication skills. Children progress from babbling easy-to-pronounce sounds (for example, 'ma-ma-ma') to forming short sentences with minor speech and semantic errors (for example, 'It [it is] a dod [dog]') before reaching conversational competency. By age nine, children use most (if not all) speech sounds in the language(s) they speak and are stringing together complex sentences with conjunctions and coordinating and subordinating clauses. The exact mechanisms behind this process are hotly debated and disputed. Authors such as Ambridge and Lieven (2011) have attempted to understand children's disposition for communication through various mechanisms. These mechanisms include lexical-constraints (where words that label objects or people, such as ‘Mum’, are more easily learnt than actions or descriptions, such as ‘soft’), social-pragmatics (where children use verbal and non-verbal cues to interpret rules of communication), and associative-learning (associating the context with what is spoken). There is no definitive conclusion or widespread agreement on how children can learn and comprehend the multifarious construct that is communication.

There exists a group of children who require the help of a speech-language therapist or pathologist (SLT or SLP) to foster their speech and language skills. SLTs work with individuals of all ages to support those who present with difficulties communicating.

Children with speech sound and language disorders are among the clients on the caseload of paediatric SLTs.

Prevalence and Incidence of Speech Sound Disorders and Developmental Language Disorder

A *Speech Sound Disorder (SSD)* is the difficulty learning and producing speech sounds that results in errors of speech beyond an age that is typically expected (Eadie et al., 2015). These can present themselves as simplified versions of speech sounds (where a child might produce a sound that is easier to articulate in place of a more difficult sound) or gaps in the phonological system (where a sound is not represented altogether) (Bowen, 2015). Statistics for the prevalence of SSDs can range widely. This wide range reflects the difficulties characterising SSD, with some researchers taking a more liberal approach, such as having less-strict criteria for categorising SSDs. The prevalence of SSD in two-to-six-year-old children is generally reported to be between 2.3-6.4% (Beitchman, 1986; Law, 2000; Shriberg et al., 1999). Persistent speech sound errors, where SSDs are still present past age eight, occur in 1-3.6% of children (Wren et al., 2016).

Developmental Language Disorder (DLD), formerly *'Specific Language Impairment'* (SLI), is the difficulty understanding and using language that results in a functional impact on a child's ability to express their wants and needs, engaging in educational curriculums, and participating in everyday activities (Bishop, 2017). Statistics for the prevalence of DLD, like SSD, also range widely due to the difficulties classifying DLD, which is discussed later in this thesis. The prevalence of DLD in five-year-old children is reported to be between 2.63-7.4% (Law et al. 2000, Tomblin et al. 1997).

SSDs do not always occur without DLD, and vice versa. In an incidence survey by Broomfield & Dodd (2004) describing the caseload characteristics of SLTs working in the

United Kingdom, one-third of children with SSDs had expressive language difficulties (identified by their performance on standardised language assessment), and half of the children with DLD had speech difficulties. Evidence-based practice for children with co-occurring SSD and DLD is sparse, despite their appearance on SLTs caseloads. Research has typically focused on children with isolated speech or language disorders, without considering children who have more diverse presentations in a clinical context, such as a co-occurring SSD and DLD (Hoover, 2019).

The exploration into the development of communication skills continues to discover how children acquire speech and language. It is becoming evident that speech and language development has a level of interaction; a child with an SSD or DLD has between an 11 to 75% chance of having a co-occurring deficit in speech or language, depending on how severe their impairment is (Beitchman, 1986; Eadie et al., 2015; Krueger & Storkel, 2016; Shriberg & Kwiatkowski, 1994; Shriberg et al., 1999). It is essential to distinguish the speech sound characteristics in a child with SSD only and the language characteristics in a child with DLD only before discussing the characteristics of children with co-occurring SSD and DLD.

Speech Sound Disorders

Definition

The umbrella term 'SSD' describes a range of labels given to children who have difficulty producing and perceiving speech sounds, known as *phonemes*. SSDs are characterised by difficulties producing phonemes due to errors in motor planning and placement of articulators and the misunderstanding and misuse of phonological rules (Brosseau-Lapré & Rvachew, 2020). For some children with SSDs, SLTs can identify a cause for these difficulties. SSDs can be *organically* based, caused by structural variations of the articulators, for example, cleft lip and palate (Howard & Lohmander, 2011); *genetic*

disorders, for example, Down Syndrome (Kent & Vorperian, 2013); *hearing loss* (Eriks-Brophy et al., 2013)*;* and *neuromotor disorders,* impairments of the nervous system resulting in muscle discoordination, weakness, or spasticity (Rvachew & Brosseau-Lapré, 2018), for example, cerebral palsy (Duffy, 2020). Nevertheless, for most children, SSDs occur for no apparent reason (Bernthal et al., 2013).

Classification systems have been created to work towards consensus in describing, assessing, and treating SSDs, where considerations such as severity, the underlying cause(s), and responses to treatment can complicate the picture of a child's presentation. A well-known system used to describe SSDs is Dodd's Four-Way Classification (Dodd, 1995; revised in 2005). Dodd's system identifies four different SSD categories: articulation disorder, phonological delay, consistent deviant phonological disorder (CDPD), and inconsistent deviant phonological disorder (IDPD).

An articulation disorder is the impaired ability to produce specific phonemes due to incorrect motor movement learning. The child always produces the same error, often a *distortion* (producing a sound that is not in a phonetic inventory of the child's language(s), such as lateralised lisp 's' (/ɬ/), or a *substitution* (producing a different sound in the child's phonetic inventory, for example saying 'dun' for 'sun').

A phonological delay is where speech sound development follows a typical developmental pattern but is delayed. Children may use phonological processes when learning how to produce and combine speech sounds. Phonological processes are speech sound patterns that make speech sounds easier to produce. For example, some children use the *omission* pattern of final consonant deletion (FCD) to delete the final consonant sound in a word, such as 'ca' for 'cat'. This process is typical until a child is three; after this age, FCD becomes a phonological delay (Bernthal et al., 2013).

CDPD and IDPD are the use of non-developmental or unusual speech sound patterns due to difficulties abstracting and using speech sound rules (CDPD) and underspecified phonological representations (IDPD) (Grunwell, 1981). For example, a child might use initial consonant deletion (ICD), the omission of the initial consonant sound in a word, saying 'at' for 'cat'. At no age is ICD considered typically developing. Children with CDPD produce their errors the same across multiple opportunities and contexts, where children with IDPD produce the errors differently or with variation in more than 40% of opportunities.

In addition to the classification system designed by Dodd (1995; 2005), speech sound error patterns occur across the four SSD groups. These errors patterns are known as substitutions, distortions, omissions and additions. Distortions, substitutions and omissions are described above when discussing articulation disorder and phonological delay. *Additions* are when a person includes an additional phoneme to a word, for example, epenthesis, where a vowel is added between two consonants ('ba-lack' for 'black').

Perceptual Abilities of Children with SSD

Phonological short term memory (PSTM) abilities in children with SSD have been investigated to understand why the breakdown of speech sound development occurs in some children. PSTM allows the temporary storage and retrieval of speech input to build vocabulary (Gathercole et al., 1999). Children use PSTM skills to develop their phonemic repertoires by forming mental representations of speech sounds (Baddeley et al., 1998). Children with SSDs have trouble discriminating words with correct speech sound productions from words with errors (Sutherland & Gillon, 2005; Tallal & Stark, 1980; Winitz, 1975; Woolf & Pilberg, 1971). Children with SSDs have difficulty distinguishing between speech sounds similar in their place, manner, or voicing, such as the velar voiceless plosive sound /k/ from the alveolar voiceless plosive sound /t/, as well as identifying when speech sounds have been produced incorrectly. The difficulty distinguishing between speech sounds leads to

phonological processes occurring in spontaneous speech (Bird & Bishop, 1992; Edwards et al., 2002; Locke, 1980).

A method of investigating PSTM is non-word repetition (NWR), a processing-dependent measure that uses *nonsense* words not found in any lexicon, such as ‘nibe’ /nɑɪb/ or ‘tayvok’ /teɪvɑk/. The use of nonsense words means the NWR task is free from prior morphological and phonological knowledge, as children have not been exposed to the test stimuli in any context. Some NWR tasks, such as that by Campbell et al. (1997), are designed to contain earlier acquired phonemes, such as /m/ and /b/, and no consonant clusters (two or more consonants that occur together). The exclusion of clusters and later developing sounds reduces competition between articulation and language competence (Dollaghan & Campbell, 1998), as languages such as Te Reo Māori do not contain clusters, and languages such as Japanese have a limited occurrence of clusters.

Nathan et al. (1998) sought to compare and contrast TD and SSD children's processing abilities on the PSTM task of NWR. They found that children with SSDs perform poorly on NWR tasks compared to their TD peers, with errors in their speech output resulting from difficulties storing phonological information. Nathan and colleagues also investigated performance on auditory-lexical tasks, where children were required to look at a picture, for example, a plate, listen to a word that was either a word or a non-word (for example, the words ‘plate’ or ‘pate’), and decide if the word matched the picture. Children with SSDs performed equally to their TD peers on this task, indicating no significant differences in the two groups' input processing abilities. However, in their systematic review and meta-analysis, Hearnshaw et al. (2019) suggested studies that report no differences in speech perception may not have used sensitive enough tasks. Hearnshaw et al. (2019) found a majority of children with SSDs performed poorly across a range of speech perception measures, including lexical

and phonological judgement tasks, as well as identification tasks (identifying what sounds have been spoken), or discrimination tasks (whether two sounds are the same or different).

Distribution of Speech Sound Errors in TD and SSD Children

It is expected that all children will have a degree of difficulty learning to produce speech sounds; the use of error patterns, such as omissions and deletions, occurs in TD and children with SSD. Researchers have identified that children aged three-years-zero-months to six-years-zero-months with SSDs used a higher proportion of omissions and substitutions and a lower proportion of distortions than their TD peers, seen in Table 1 (Shriberg & Kwiatkowski, 1994). These findings reflect the evidence that although TD children are expected to exhibit speech sound errors, there are differences in the type of errors and frequency they occur compared with children with SSD.

Table 1

Distribution of Error Patterns in Typically Developing and Children with Speech Sound Disorders aged 3-6-years (Shriberg & Kwiatkowski, 1994)

Distribution of Errors	**TD**	**SSD**
Omissions	5.1%	25.4%
Substitutions	13.7%	47.4%
Distortions	81.1%	27.2%

Note. TD = Typically Developing Group; SSD = Speech Sound Disorder group

Developmental Language Disorder

Terminology

A range of terms have been used to refer to children's difficulties with language disorders. Childhood language disorder was commonly called *Specific Language Impairment (SLI)*, although many terms have been used, including *Language Learning Impairment (LLI)* (Bishop et al., 2012). This terminology was felt to describe language disorders inaccurately (Bishop, 2017), and Lahey (1990) advocated for the need for consensus on the criteria for diagnosing language disorder to reduce confusion for clients, service providers, and SLTs.

In 2015, the Criteria and Terminology Applied to Language Impairments: Synthesising the Evidence (CATALISE) project (Bishop et al., 2016) was established to reach a consensus on childhood language disorder and the diagnostic criteria to identify it. The outcomes of the project suggested DLD become the preferred and singularly used term to describe language deficits. However, this is yet to eventuate, as previous terms are still commonly accepted and used (Graham et al., 2020; Nicola & Watter, 2018; Spanoudis et al., 2019; Wittke & Spaulding, 2018).

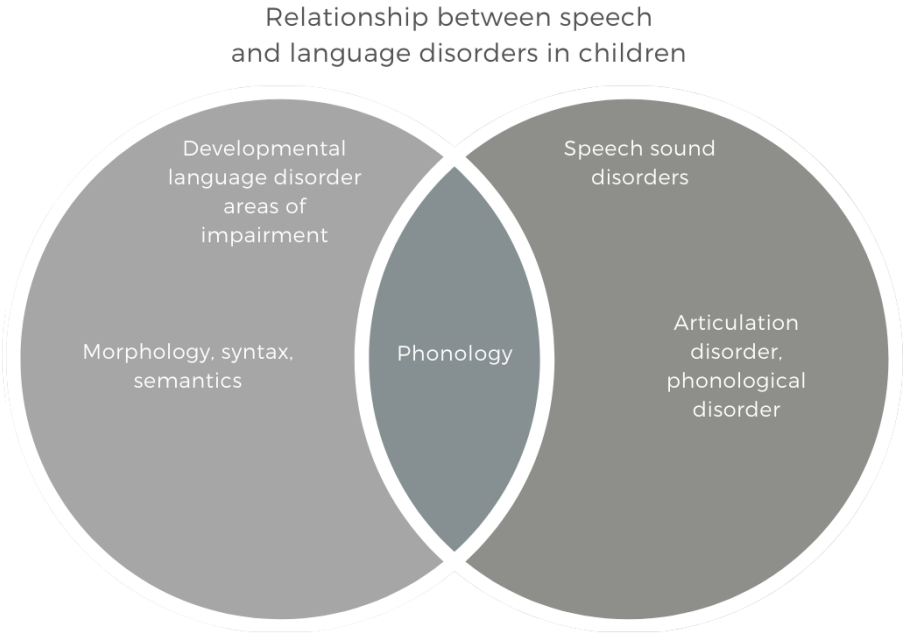
The American Speech-Language and Hearing Association (ASHA) (1993) characterises language disorder as "an impairment in the comprehension and use of spoken or written systems, involving form (phonology, morphology and syntax), content (semantics), and the function of language in communication (pragmatics, discourse)". This thesis will use the definition from the CATALISE project by Bishop et al. (2017), which identifies DLD as language difficulties with no biomedical or differentiating cause (i.e. no complex aetiologies)

and the likelihood of a poor prognosis resulting in a functional impact continuing into the child's adolescence and adulthood.

Figure 1 depicts how co-occurring SSD and DLD classifications overlap, namely how phonological deficits may be associated with co-occurring SSD and DLD. A diagnosis of DLD is associated with difficulties in *morphology*, *syntax*, and *semantics*. Morphology is concerned with the internal structure of words and how they are broken into morphemes, the smallest unit of meaning. Difficulties with morphology may result in the exclusion of morphemes, such as the omission of past tense –ed from 'kicked' (Paul et al., 2018). Syntax is the structure of sentences and how words are combined to create phrases. Difficulties with syntax may result in incorrect word order or omissions of words in sentences. For example, a child with DLD might exclude obligatory words from a sentence, such as '(the) boy (wants the) ball' (Schwartz & Ebooks, 2009). Semantics is concerned with the meaning of words and

Figure 1

Overlap of DLD & SSD. Authors Own Image, Adapted from Bishop et al. (2017) CC BY.



phrases (Brackenbury & Pye, 2005). Semantics includes word acquisition and the storage and retrieval of words from our lexical representation system (discussed later).

Causes of DLD

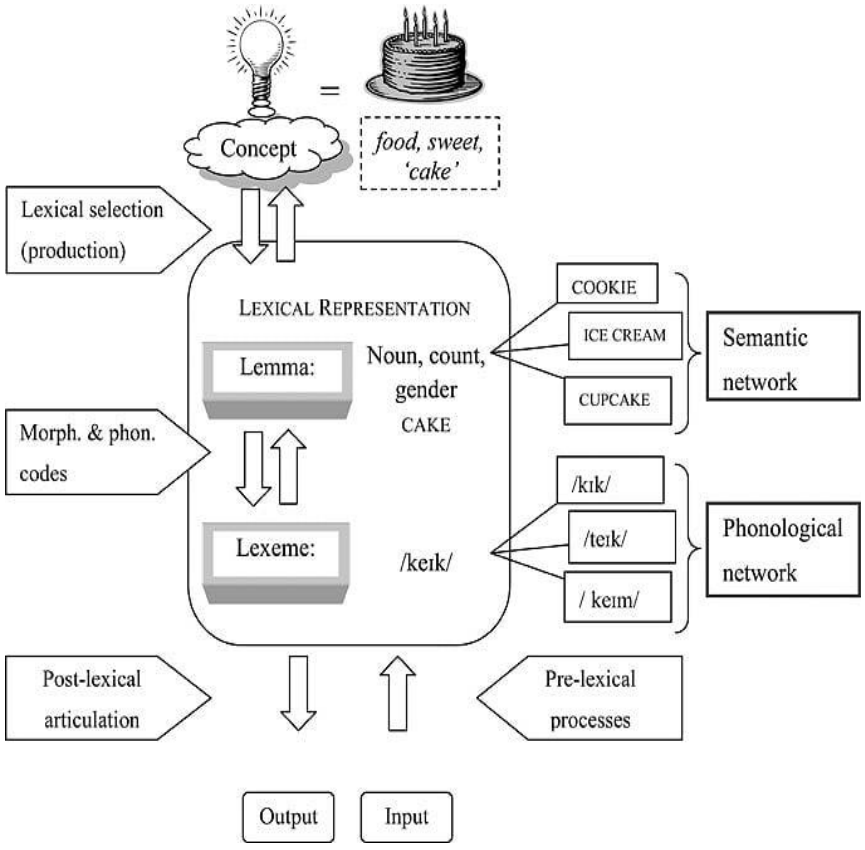
No child with DLD presents with the same language difficulties or has the same underlying deficits in cognitive processing (Bishop, 2006). Multiple underlying deficits likely contribute to children having DLD, as well as the influence of other risk factors such as a family history of DLD (Lahey & Edwards, 1995), or environmental factors such as limited language input in the first few years of life (Hoff, 2006). DLD presents as the primary condition and is not attributed to other biomedical aetiologies (Plante, 1998). DLD is most likely caused by multiple underlying deficits, including poor auditory temporal processing (Protopapas, 2014; Tallal & Piercy, 1973; Tallal & Stark, 1981), and limited processing capacity (Archibald & Gathercole, 2007; Just et al., 1996; Weismer et al., 1999). Poor auditory temporal processing is the reduced ability to distinguish and discriminate acoustic information, leading to speech sound being processed inaccurately (Tallal & Stark, 1981). Limited processing capacity and slowed speech processing encompasses PSTM; children with SSD and children with DLD have difficulties with NWR compared to age and language matched TD children. Impairments in PSTM are thought to be associated with phonological processing (Chiat, 2001; Ullman & Pierpont, 2005). Chiat (2001)'s mapping theory proposes children extract meaning from linguistic situations and extract form from the sound wave. Due to their difficulties with PSTM and phonological processing, children with DLD (as a group) have a reduced ability to use incoming phonological information to extract morphological rules. For example, a weak representation of the plural marker (final /s/ sound) across word tokens is thought to slow the acquisition of this morphological rule.

An Interaction of Systems in Speech and Language Development

Speech and language development has a level of interaction. The interaction between the speech and language systems can be seen in the following Lexical Representation model (Figure 2), described by Levelt (2001) and illustrated by Jarmulowicz and Taran (2013). When listening to speech information, the *input* processing system is activated to interpret the information. If someone said ‘cake’, the listener needs to understand the various elements of the word. The listener discriminates the phonemes in the word, for example, /k/ + /eɪ / + /k/, and distinguishes them from similar-sounding phonemes and the words they create (Tognini-Bonelli, 2001) such as ‘came’, ‘take’, or ‘kick’. The listener needs to understand the specific

Figure 2

Lexical Representation, based on Levelt (2001). Sourced from Jarmulowicz and Taran (2013). Copyright 2013 by Topics in Language Disorders. Reprinted with Permission.



combination of those sounds (/k/ + /eɪ/ + /k/) creates the word ‘cake’, work done by the *phonological network*. While processing speech information, the listener needs to comprehend what ‘cake’ represents. In this example, a ‘cake’ is a round, spongy food. The listener fits this information into their ever-growing semantic map, creating links with the characteristics of a ‘cake’, such as that it is sweet and served for dessert. Similarly represented words are accessed by the semantic network (Fey et al., 1994) and could include ‘cookie’ or ‘ice cream’.

On the opposite channel of the lexical representation network, we activate the *output* stage. If a speaker wanted to say the word ‘cake’, they would recall information about the word (*lexical selection*), identifying its features and representations. The word ‘cake’ might be represented with the information that it is topped with icing. Lexical selection involves eliminating similar words which might have the same representation, such as ‘cupcake’ or ‘muffin’. The word is coded with the phonological information /k/ + /eɪ/ + /k/, and articulated.

Research has shown that infants learning to communicate are sensitive to characteristics of speech, such as prosody (stress, tone, and intonation of voice) and segmental details (the smallest units in the speech stream which can be identified) (Kuiper & Allan, 2017; Morgan & Demuth, 2014; Tsao et al., 2004). These speech properties give children information on language structure, helping them understand how a verbal sentence is segmented into words (as verbal speech is spoken in a single breath with no pauses to indicate where one word ends and another begins). Children’s ability to interpret connected speech into single words allows them to identify syntactic relationships (the arrangement of words), vital elements of language acquisition (Chiat & Roy, 2008; Leonard, 2000). This sensitivity to speech properties suggests that when the phonological system is impaired (as is the case for DLD), there is a subsequent impact on language acquisition. In support of this

theory, children with DLD have difficulty distinguishing stress patterns, poor NWR (Chiat, 2001, 2006; Claessen et al., 2013; Gathercole, 2006) and difficulty with phonologically challenging morphology, such as unstressed inflections on function words (i.e. auxiliary - verbs, pronouns, and conjunctions).

Children with Co-Occurring SSD and DLD

SSD and DLD can be presented as comorbid disorders (Broomfield & Dodd, 2004; Eadie et al., 2015; Shriberg & Kwiatkowski, 1994). When a child has co-occurring SSD and DLD, it can be challenging to determine whether some errors are speech- or language-related. For example, the /s/ phoneme expresses third-person singular –s (3S) morphology. If a child has SSD, the omission of the /z/ from 'plays' could be attributed to the phonological process of FCD. If a child has DLD, this error could be attributed to difficulties acquiring 3S morphology. If a child has co-occurring SSD and DLD, omission patterns could be due to their SSD, DLD, or both. SLTs need to take care with these children when completing an assessment and interpreting their results to identify whether the errors are speech- or language-based, or both.

Speech Errors of Children with Co-Occurring SSD and DLD

There are distinctions between the speech profiles of children with co-occurring SSD and DLD compared to children with SSD only and TD children. Shriberg and Kwiatkowski (1994) found children with co-occurring SSD and DLD are less accurate in their production of phonemes (particularly nasals, such as /n/, and plosives, such as /t/) and have a different distribution of their error types, compared to children with SSD only and TD children. Children with co-occurring SSD and DLD use more omissions and substitutions and fewer additions and distortions than children with isolated SSD or TD children (Liu & Chien, 2020; Macrae & Tyler, 2014; Shriberg & Kwiatkowski, 1994).

Increases in the use of omissions and substitutions in children with co-occurring SSD and DLD reflects their cognitive-linguistic processing skills, the ability to process phonological information at the phonemic (single-sound) level (Dodd & McIntosh, 2008). Children with co-occurring SSD and DLD have more compromised cognitive-linguistic systems resulting in linguistic representations of word morphology being absent (Alt, 2011; Macrae & Tyler, 2014; Shriberg et al., 2005). For example, such a child may have a partial representation of a word, such as 'kick', but may not represent the morphology to indicate the tense, such as the /s/ phoneme required for 3S 'kicks'. Morphology errors may co-occur with omission patterns such as final consonant deletion FCD ('dog' to 'do') and or cluster reduction ('ask' to 'ak'). In contrast, children with SSD may represent the morphology but cannot produce the sound(s) in the word correctly due to FCD and or cluster reduction. Several researchers, namely Nathan et al. (1998; 2004) and Sices et al. (2007), found the difference in error distribution between children with isolated SSD and children with co-occurring SSD and DLD led to decreased scores in percent consonants correct (PCC) scores in the children with co-occurring disorders. However, this finding was not replicated by Macrae and Tyler (2014). One suggestion provided by Macrae and Tyler (2014) is that a child's language ability may not correlate with the severity of their SSD, which will be discussed later in this thesis.

Language Errors of Children with Co-Occurring SSD and DLD

Unique language patterns have been observed in children with co-occurring SSD and DLD. Children with DLD have more severe difficulties understanding and using finite morphemes (words relating to tense, person, mood, or agreement, such as past tense –ed or plural -s) (Ash & Redmond, 2014; Rice et al., 1995), compared to non-finite morphemes, which do not indicate morphology such as tense or person, for example, infinitives such as 'to walk' (Haskill & Tyler, 2007; Howland et al., 2019; Mortimer & Rvachew, 2009). These

difficulties are exacerbated in children with co-occurring SSD and DLD, with the most considerable difficulties seen in words with final clusters, such as ‘kicked’ /kɪkt/, compared to singleton and syllabic consonants, such as ‘waited’ /weɪtɪd/. The increased difficulty producing clusters follows the *prosodic licensing hypothesis* (Demuth & McCullough, 2009); the ability to realise grammatical morphemes through phonological and prosodic competence. The more simple the phonological input (for example, singleton consonant-vowel structures, such as ‘bye’ /baɪ/, or early-acquired speech sounds, such as /m/ and /b/), the easier a word is to acquire.

Phonological Short Term Memory in Children with Co-Occurring SSD and DLD

In addition to investigating TD children's input and output capabilities and those with SSDs, Nathan et al. (1998) also included a group of children with co-occurring SSD and DLD. These children presented with difficulties completing both the input auditory-lexical task and the output NWR task, compared to TD and SSD children, who only had difficulty on the output task. These results indicate children with co-occurring SSD and DLD have more severe PSTM deficits (Gray et al., 2019; Torres et al., 2020). For children with co-occurring SSD and DLD, their speech input storage decays more rapidly than TD children, children with co-occurring SSD or DLD only, and combined with their output errors, the decay of speech input results in their speech being more inaccurately represented in its phonology and morphology. Children with co-occurring DLD and SSD have been shown to have weaker phonological processing skills in phonological retrieval, awareness, and encoding tasks (Leitãto et al., 1997)

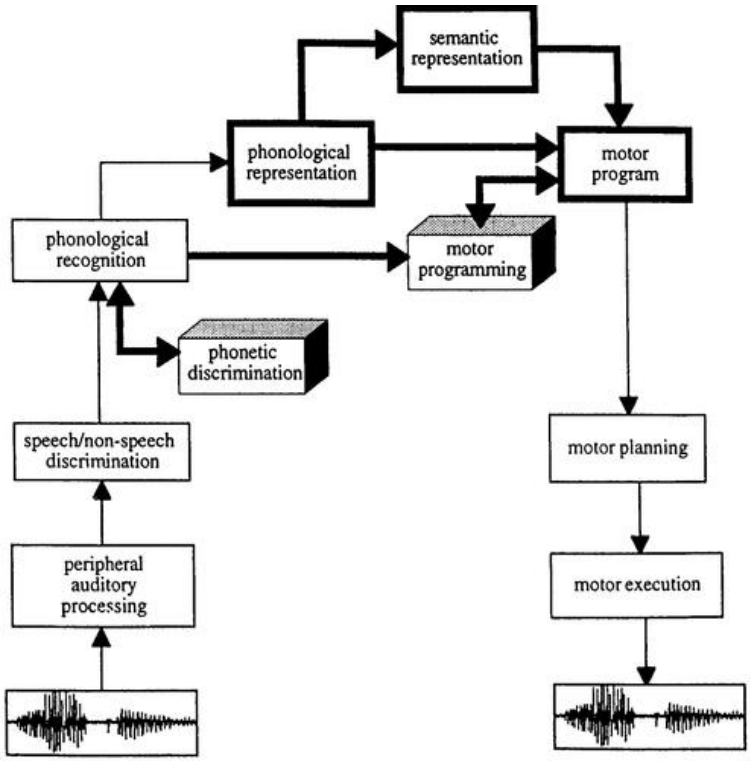
Impact of Severity

There is a lack of agreement across the literature in how severity impacts characteristics of co-occurring SSD and DLD and to what extent this influences intervention

outcomes. The severity of the SSD does not always correspond to the severity of the language disorder. Ruscello et al. (1991) found that children with mild-moderate SSDs had equal language skills to children with severe SSDs. However, Shelton and McReynolds (1979) previously suggested that children with more severe SSDs were more likely to have a language disorder. The severity of DLD can impact speech production; Torres et al. (2020) found children with severe DLD used a higher number of phonological processes, which was associated with their performance on NWR tasks and their PSTM ability. There is a more significant impact of language ability on speech sound production than vice versa. The impact of speech sound production on DLD can be visualised in Stackhouse & Well's (1997) psycholinguistic framework (Figure 3). To learn to produce speech sounds, children may

Figure 3

The Speech Processing Model (Stackhouse & Wells, 1997), Illustrating the Direction of the Development of Speech and Language. Copyright John Wiley & Sons. Reproduced with Permission.



need enough variability in their vocabulary where each speech sound is represented in multiple contexts. For example, a phoneme may occur in the initial, middle, and final word position. A speech sound may also occur as a part of a cluster, where other consonants' influence makes the sound more difficult to produce (Gierut, 1999). For a child with DLD, having only a small number of different words and difficulties combining words may not allow for enough variability in their vocabulary to practice producing speech sounds and the contexts they are presented in. This lack of variability could lead to a higher frequency of errors (Edwards et al., 2004) and may explain why Torres et al. (2020) found children with severe DLD are more likely to have more severe SSDs than the weaker impact of severe SSD on language skills found in Macrae and Tyler (2014).

Regardless of the impact the severity of the SSD has on language skills and the severity of DLD on speech development, it is agreed that children with co-occurring SSD and DLD are more likely to experience persistent disorders compared to their peers who have isolated SSD or DLD (Bishop & Edmundson, 1987; Haskill & Tyler, 2007; Lewis et al., 2000), as previously described.

Interventions for Children with Co-Occurring SSD and DLD

History

Before the 1970s, there was little research evidence to support interventions for children who had difficulties in speech and language. Most intervention programmes were run independently of one another, with children being identified in the literature as having ‘speech only’ or ‘language only’ concerns. Evidence at the time supported these approaches, noting children who had difficulties articulating made gains in their speech compared to children who did not receive intervention (Sommers et al., 1967). Increasingly, more consideration was given to school-aged children who appeared to present with language

difficulties and speech errors (Menyuk & Looney, 1972). Researchers began documenting occurrences where children experienced indirect growth in phonology following direct language intervention (Panagos, 1974) and growth in language components following phonological intervention. This realisation led to inquiries into co-occurring SSD and DLD and interventions for these children. Several reviews have been completed to identify the range of intervention studies, such as Tyler (2016) and Hoover (2019). Both reviews provided suggestions for clinicians to choose treatment targets that will lead to system-wide improvements across multiple domains and cite the need to appraise multiple-domain interventions to evaluate current service provision. However, neither researchers completed an extensive review. Therefore, further exploration into the evidence base for interventions for children with co-occurring SSD and DLD is needed. A summary of the relevant intervention studies is provided in Appendix 1. A complete list and description of the speech and language intervention methods have been provided in Appendix 2. It should be noted the following intervention studies use a range of terminology to define the speech and language characteristics of their participants, for example, 'articulatory disorders', 'phonological impairments', 'language difficulties', and 'syntactic problems'. This author has endeavoured to identify and describe the characteristics of the participants included in the studies based on the information provided.

Early Research

To probe further into the early developments in cross-domain effects of speech and language intervention and provide insight for researchers and clinicians working with children with speech and language difficulties, Matheny and Panagos (1978) devised an investigation into articulation and syntax intervention for 24 children aged five-years-five-months and six-years-ten-months with 'functional articulatory and syntactic problems'. The researchers compared the effects of an articulation programme (Baker & Ryan, 1971) and a

syntax programme (Gray & Ryan, 1973), with no treatment, with participants randomly assigned to one of the three groups. Children in the two intervention groups improved in their directly targeted domain following five months of intervention. Significant cross-domain improvements in phonology were found in the syntax intervention group and syntax improvements in the articulation intervention group. However, Matheny and Panagos (1978) provided a lack of detail around the children's speech and language characteristics involved in their study, including the speech sound errors they presented with, their language characteristics, and their severity. Their results should thus be interpreted cautiously.

The work of Matheny and Panagos (1978) led to more research being launched by Hoffman et al. (1990) and Tyler and Sandoval (1994). Hoffman et al. (1990) recruited two brothers aged four-years-one-month with moderate phonological impairments and low-average language skills, and Tyler and Sandoval (1994) recruited six children aged three-years-six-months to four-years-eight-months with severe phonological and language disorders. Both researchers investigated the effects of a phonological compared to a whole-language narrative approach, with the phonological approach utilising *minimal pairs* (in both studies) and the whole-language approach utilising meaningful story listening and recalling (Hoffman et al., 1990), or indirect narrative-focused stimulation (Tyler & Sandoval, 1994). Minimal pairs is a phonological intervention where a set of words differ by a single phoneme, allowing children to understand how speech sounds can change word meaning. For example, a child with a phonological impairment may say ‘cook’ when they mean to say ‘look’. The clinician provides opportunities to make distinctions between the two words to correct the child’s phonology. Minimal pairs is described in detail in the Methods section of this thesis. Tyler & Sandoval (1994) also included a combination condition, where participants experienced both phonological and language interventions. In both Hoffman et al. (1990) and Tyler & Sandoval (1994), children experienced more significant gains in the directly targeted

domain than the indirectly targeted domain (for example, more significant gains in phonology were seen in the phonology group compared to the language group). Children in the phonological intervention improved in phonological measures, such as PCC, and decreased their frequency of phonological processes used. Children in the phonological intervention groups also experienced improvements in language skills, such as the production of simple and complex sentences, made fewer syntactic errors, decreased their verb errors, increased their mean length of utterance (MLU), and advanced in Brown's stages (Brown, 1973). The participant in the language condition experienced significant improvements in their PCC, decreased their use of phonological processes, increased their use of simple and complex sentences, and had fewer verb tense errors.

Similar conclusions could not be drawn from the participants in Tyler & Sandoval (1994). In their indirect narrative group, children had negligible changes in their phonology and marked improvement in their MLU and Brown's stages. The researchers provided a potential hypothesis for these results, suggesting this lack of improvement may be due to participants in the language group having more moderate to severe speech and language deficits. These deficits are compared to children in the phonological group, who had milder deficits, and children in Hoffman et al. (1990) and Matheny & Panagos (1978), who were reported to have mild-moderate impairments in phonology and low average language skills. Results from Hoffman et al. (1990) should be approached carefully due to the participant's low-average language performance, as these children are not immediately diagnosed with a language disorder and may not be comparable with children with DLD. Saben and Ingham (1991) and Elbert (1992) report that children who use phonological processes require direct practice or drill of accurate productions to improve their phonology. Therefore, children with more severe impairments such as those in Hoffman et al. (1990)'s indirect narrative group may require more direct phonological intervention before improvements are seen. Tyler &

Sandoval (1994) also reported that children in their combined phonological and language groups made clear improvement in phonology and morphology, reducing their percentage of phonological processes, increasing PCC and MLU, advanced in at least one Brown's stage, and improved in the accuracy of plurals. In contrast to the severe deficits of the children in the language group, these children had the least severe deficits in phonology and language, which are thought to contribute, in part, to these promising results.

Equivocal Findings

The cross-domain effects of phonological and language intervention seen in Hoffman et al. (1990) and Tyler & Sandoval (1994) were not consistently replicated, as evidenced by Tyler & Watterson (1991) and Fey et al. (1994). Tyler and Watterson (1991) employed an intervention approach similar to Hoffman et al. (1990), comparing the performance of 12 children with language and phonological disorders aged three-years-seven-months to five-years-seven-months. Participants were allocated to one of two groups; a phonological-based minimal pairs approach and a language-based scripts intervention. The scripts intervention involved the clinician and child reading a story together, followed by real or role-played scenarios to encourage the child to retell the story, utilising clinician feedback, modelling and questioning. Consistent with previous research, the children made gains in the directly targeted area; children in the phonological intervention group made gains in phonology as measured by PCC. Children in the language intervention group made gains in language, as measured by MLU.

Tyler & Watterson (1991) did not find any evidence to suggest children improved in the area not directly targeted. With further investigation, they concluded this was likely due to the severe nature of speech and language impairments of the children in their study. Fey et al. (1994) also recruited participants with severe deficits of speech and language. Twenty-six children aged four-years-six-months to five-years-eight-months with moderate to profound

phonological language deficits were randomly allocated to one of three groups. These consisted of two intervention groups, using a *focused language stimulation* (FLS) programme. FLS is the auditory bombardment of target words during play to provide structured models of words in various contexts, for example, parallel talk, where the clinician comments on what the child is doing (Lederer, 2002) (described in detail in the Methods section of this thesis). Group 1 (G1) completed a clinician-administered programme, and group 2 (G2) completed a parent-implemented intervention programme. Group 3 served as a delayed intervention control. Following an extensive intervention period (where some participants participated in intervention for 9 ½ months), the researchers found no significant improvements in the phonology measures in both G1 and G2 compared to G3. However, there were significant gains in language in the two intervention groups, which lead the researchers to conclude moderate to profound impairments in phonology does not impede significant gains in language.

As well as theorising that the severe nature of the participant's co-occurring SSD and DLD impacted the children's ability to experience cross-domain effects, Fey et al. (1994) also suggested the intervention methods used in Matheny & Panagos (1978) and Hoffman et al. (1990) were perhaps more 'direct' than first thought. The articulation and syntax programmes used in Matheny & Panagos (1978) involved a high level of imitation and reinforcement in a clinician-led intervention, resulting in children receiving direct speech or phonological instruction during the syntax task and vice versa. During the language tasks in Hoffman et al. (1990), clinicians provided accurate speech models, recasted sentences, and requested more information when a child produced an unintelligible response. Fey et al. (1994) described that not only were children able to seek new grammatical or morphological replies following breakdowns to provide more information; they also used new, more accurate patterns of phonology rather than continuing to use error patterns to be understood

more clearly and in line with the clinician's model. This provision of direct speech models may have contributed to the language intervention having a more 'direct' phonological element than first described.

Storybook Intervention Effects on Speech and Language

Bellon-Harn et al. (2004) and Bellon-Harn and Credeur-Pampolina (2016) investigated a storybook intervention approach as an alternative to language stimulation approaches. Interactive storybook reading is a method for increasing a child's linguistic complexity and retelling skills through strategies such as expansions, where the clinician responds to a child by repeating the child's utterance with more meaningful language, and cloze procedures, where the child completes the adult's utterance (Bradshaw et al., 1998; Wong et al., 2012). Expansions and cloze procedures have been shown to improve phonology (Hoffman, 1997; Lawrence, 2014). The researchers recruited three children aged five-years-six-months and five-years-ten-months with consistent co-occurring SSD and DLD (2004), and two children aged five-years seven-months and five-years-four-months, the older with CDPD and DLD and the younger with IDPD and DLD (2016). In addition to using expansion and cloze procedures prompts, the researchers also used contrast word pairs (minimal pairs) to respond to incorrect productions. Following intervention, participants in Bellon-Harn et al. (2004) and the child with CDPD and DLD in Bellon-Harn and Credeur-Pampolina (2016) showed significant improvements in both language and speech measures. Participants increased their utterances' complexity by using substantially more descriptors (phrases describing attributes and actions of people or objects) and interpretations (inferences taken from the text). Participants also increased their PCC and decreased the frequency of their phonological processes. In particular, the expansion and cloze procedures both resulted in increases in phonemic and syntactic complexity. The researchers discussed the participants' had more complex syntactic utterances and accurate phonology following the use of both

expansion and cloze procedure prompts than only one of expansions, only cloze procedure, or contrast word pairs. The contrast word pairs were associated with improved phonemic revisions and production accuracy but had no impact on linguistic complexity. For example, if a participant said 'the dun (sun)', the clinician would prompt the child with the contrast word pairs, in this case, 'sun' and 'dun', requiring the child to clarify what word they were intending to say, revising to 'the sun'. The participant with IDPD and DLD also improved their PCC and experienced decreases in their use of phonological processes, but to a lesser extent than participants with consistent errors. The participant with IDPD had more severe phonological deficits, as is often the case for children with IDPD, so it is promising to note that storybook reading can be effective with this population. However, they may require more intensive or direct therapy to show significant gains in treatment measures.

A Combination Approach

Perhaps the most significant research into the intervention studies for children with co-occurring SSD and DLD is from Tyler and colleagues (2011; 2002; 2003). Tyler continued to build on her previous work to design several intervention studies focused on investigating the effects of alternating (2002) versus simultaneous (2003) therapy approaches. In their 2002 study, 20 participants aged between three-years-zero-months and five-years-11-months with co-occurring SSD and DLD were randomly allocated to one of two groups; phonology-first or morphosyntax-first, where participants completed one 12 week block of one intervention before completing a second block of the other. In the phonology-first condition, researchers instructed the participants using auditory awareness, contrastive sound pairs, drill, naturalistic play, and PA. In the morphosyntax-first condition, researchers instructed the participants using auditory awareness, focused stimulation and elicited production. After completing the two blocks, each group illustrated the most substantial improvements in the approach they were targeted in first; that is, PCC improved more

significantly in the phonology-first group and MLU for the morphosyntax-first group. However, a group difference was seen in the morphosyntax-first group; these children experienced more significant improvements in their phonological skills after both the first and second block of intervention, compared to the morphosyntax skills of the participants in the phonology-first group. In fact, the phonology-first group participants did not record any significant gains in MLU after either block. Tyler et al. (2002) discussed that morphosyntax interventions appear to be powerful facilitators of phonological change. Participants in the morphosyntax-first group were already being exposed to a high number of accurate repetitions of phonological models, so during their phonological block of intervention, participants were able to achieve their goals quicker, moving towards a higher level of phonological complexity than children in the phonology-first group. Participants in the morphosyntax-first group maintained their gains during the phonological intervention, and several participants continued to improve in their morphosyntax skills.

In contrast, children in the phonology-first group may not have received enough direct morphosyntax treatment to make significant morphological gains and had no opportunity to indirectly learn morphology during the phonological intervention. During the phonological intervention, children listened to target words elicited by the clinician during storybook reading, practised producing sounds during drill activities, and participated in metaphon (Howell & Dean, 1994) and PA activities. Children in the phonology group experiencing no change in their morphology could be due to the phonological interventions targeting speech sounds in contexts devoid of language content or without giving children the opportunity to practice speech sounds in more complex language structures. For example, children may have practised the sound /f/ in isolation, or the /f/ sound in the word ‘fan’, but not in at phrase level ‘that is a fan’, or ‘she fanned her face’. It is difficult to tease apart what gains are part of the

'direct' or 'indirect' method and the impact of generalisation skills, consolidation time, and natural maturation.

Tyler et al. (2003) completed another investigation into the cross-domain effects of speech and language intervention with 40 children aged three-years-zero-months to five-years-eleven-months with co-occurring SSD and DLD; this time introducing alternating and simultaneous intervention conditions, in addition to the morphosyntax- and phonology-first conditions. The alternating condition consisted of alternating sessions, where one week focused on speech, and the second focused on language. The simultaneous condition consisted of speech and language activities occurring within the same session. The researchers also included 7 TD children for the same purposes at Tyler et al. (2002). After the first 12 week intervention period, researchers found direct phonological change, measured by phoneme production accuracy and generalisation to non-target sounds, was most significant in the morphosyntax first, alternating and simultaneous groups, with each of these groups experiencing similar gains, as compared with the phonology first group and TD controls. Direct morphological change, measured by MLU and Brown's stages, was most significant in the morphosyntax first and alternating groups. After a further 12 weeks of intervention, there were no group differences found in phonological ability. When measuring morphology, participants in the alternating group had the highest gains in MLU, with the other three groups experiencing similar levels of morphological change. From these results, it is suggested the best method for intervention with children with co-occurring SSD and DLD from the groups investigated is an alternating approach, followed by a morphosyntax-first approach, with comparable results in the simultaneous and phonology-first groups. Parallel with Tyler et al. (2002), participants in the phonology-first group experienced no significant changes in their morphology, and participants in the morphosyntax-first group experienced significant gains in their phonology. The largest gains in morphology and phonology were

found in the alternating therapy group. The results from this intervention condition suggest targeting both phonology and morphology as a concurrent intervention will create more considerable gains in both areas simultaneously. It also suggests these gains are more significant than if one isolated area is targeted, as participants in the alternating condition experienced more considerable gains in phonology than participants in the phonology-first group.

Tyler et al. (2011) investigated the effects of an intervention programme that included a treatment condition targeting phonological awareness (PA) and speech sounds (PA+SS), compared with a morphological and phonological group (MS+SS). Participants consisted of 30 children aged three-years-ten-months to five-years-two-months with co-occurring SSD and DLD. Participants were randomly allocated to either PA+SS or MS+SS. The PA+SS group were trained in phoneme isolation, detection, matching, categorisation, letter-sound knowledge activities, and targeted practice of their speech production, facilitated through the PA activities. Participants in the MS+SS group received the alternating intervention approach outlined in Tyler et al. (2003). The PA measures used included phoneme identity and letter knowledge. The speech measures included PCC and cluster accuracy. The language measures included finite morphology and MLU. Following intervention, the researchers concluded both the PA+SS and MS+SS groups significantly improved all outcome measures of PA, speech, and morphology. PCC scores were higher in the PA+SS group than the MS+SS group, and participants in the MS+SS group had larger MLUs than children in the PA+SS group.

Recent Single-Subject Case Designs

Two single-subject case designs have been completed by Seeff-Gabriel et al. (2012) and Combiths et al. (2019). Seeff-Gabriel et al. (2012) recruited a five-year one-month-old child with moderate to severe co-occurring SSD and DLD. Seeff-Gabriel et al. (2012)

completed intervention in two stages; the first stage targeting the participant's past tense morphology using auditory bombardment, role-play and visual cues, and production activities. The second stage targeted the participant's articulation of word-final /s/, as the participant exhibited difficulties in both the phonological and morphological aspect of plural –s. The researchers selected an articulation approach for the second stage, despite the participant appearing to present with a phonological disorder, indicated by their use of cluster reduction, fronting of velars, and stopping of fricatives. Articulation approaches are motor-based and target the production of sounds through a hierarchical approach, where phonological approaches are rule-based and target the phonological patterns. Following stage 1, the participant exhibited significant improvements in their regular past tense –ed productions and mild improvements in irregular past tense. During stage 2, the participant achieved mastery of /s/ productions in word-final position and could mark –s morphology for plurals.

Combiths et al. (2019) recruited a five-year and two-month-old participant with a moderate to severe phonological impairment and DLD. Combiths et al. (2019) investigated the effects of intervention targeted at complex phonology and morphology forms, including word-final clusters (WFC) in 3S words and the generalisation effects to singleton consonants and base words. The intervention was a two-phased phonology programme, with phase one using a drill-play format and phase two using role-play and collaborative storytelling. The participant showed improvement across a range of sounds, for example, increasing their phonemic repertoire and accuracy of speech sounds. However, there was minimal improvement in their morphology. Minimal gains in targeted 3S structures and past tense forms were seen, with no plural morphology improvement. The participant exhibited growth in their morphological system during post-test measures when the researchers analysed the language sample. However, this cannot be solely attributed to the intervention given the

impact of natural maturation and lack of control measures, such as non-targeted language forms. These latter two studies added a new component to the intervention literature for co-occurring speech and language difficulties, investigating the cross-domain effects of therapy programmes and introducing target words complex in their phonology and morphology.

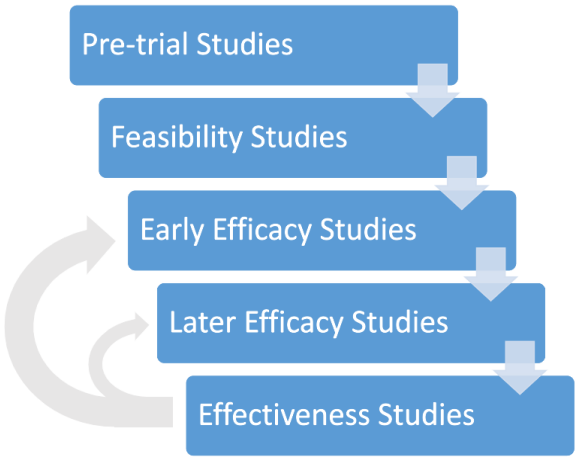
In speech sound and language interventions, a hierarchy of targets can be created, ranging from simple to complex. Complexity approaches target 'the hard things first'; sounds or words that are more developmentally advanced. Complexity approaches are done with the aim that 'harder' productions, such as consonant clusters, will be more likely to generalise to 'easy' productions, such as singleton consonants, compared to easy targets generalising to hard targets. Complexity approaches have been reported in intervention studies for SSD only (Gierut, 1999) and DLD only (Van Horne et al., 2017). Gierut (1999) found that using three-element clusters, for example /skr/, lead to broader speech sound generalisation to two-element clusters, such as /sk/ and singleton consonants /s/, /k/, and /r/. As discussed earlier, children with DLD and children with co-occurring SSD and DLD have difficulties with complex morphology, such as finite morphemes, compared to less complex morphology, such as nonfinite morphemes. Van Horne et al. (2017) used this knowledge to investigate a morphosyntax intervention, where participants received language intervention with verbs increasing in complexity, from 'easy' (for example, trip) to 'difficult' (for example, 'rest'). Children who were taught to use the regular past tense with the more complex morphology experienced greater improvements in their morphology and considerable generalisation across their wider language system than those taught using easier verbs.

Feasibility Studies

Fey et al. (2009) described a five-phase model of designing and implementing intervention research in language disorders, which can be applied to the broader

Figure 4

A Five-Phase Model for Intervention Research. Authors Own Image, Adapted from (Fey et al., 2009) with Permission. Copyright 2009 by Taylor and Francis.



communication disorders domain (Figure 4). The first of these five stages is the early development or pre-trial study. These studies are observational or correlational, where researchers analyse the effect of an intervention without manipulating or controlling for variables or analyse the relationship between two variables (Hackshaw, 2015; Lau & Kuziemsky, 2016). These studies allow researchers to generate hypotheses about the intervention methods based on their underlying theories and guides the next phase of intervention research, feasibility studies.

Feasibility studies are used to determine whether an intervention procedure's key elements are viable and worth investing time and resources into developing and implementing to a wider participant pool under more scientific rigour. Feasibility studies focus more on the question, ‘can this work?’, before answering the question ‘does this work?’ (Orsmond & Cohn, 2015), which is especially important in the clinical environments of SLTs. Gadke et al. (2021) suggest that research hypotheses may not be worth investigating if they cannot be replicated and adopted into clinical practice, an environment with more constraints than research environments. However, the investigation of hypotheses, regardless

of their application to clinical contexts, can broaden our understanding of the impact of participants' deficits and the feasibility of intervention procedures. Gadke et al. (2021) stressed the value of feasibility studies to bridge the gap between research evidence and clinical practice. Feasibility studies identify the factors which may facilitate or hinder the evaluation of intervention procedures, outcome measures, and research techniques in early or later efficacy and effectiveness studies (Bowen et al., 2009).

The Current Study

The state of evidence in intervention studies for children with co-occurring SSD and DLD is emergent. A range of study designs have been employed to investigate interventions for children with co-occurring SSD and DLD. To date, there is promising evidence to suggest children with co-occurring SSD and DLD improve in both their speech and language skills during morphological only (Hoffman et al., 1990) or morphological and phonological interventions (Tyler et al., 2003), but only improve in their speech accuracy, not language production, during the phonological intervention (Tyler et al., 2002). Although promising, there remain conflicting results across the literature, such as Fey et al. (1994) finding no improvement in participants' phonological abilities. Several complicating factors contribute to these results that need further investigation, such as the impact of severity, and as Tyler et al. (2002) suggest, participants' temperament and learning styles. With the limited number of studies published in this area, the broad range of study designs, and the range of intervention methods investigated, more research is needed to tease apart the mechanisms that facilitate speech and language development in children with co-occurring SSD and DLD, for example the analysis of participant’s speech and language skills, and the change in their performance following intervention.

The contribution of Seeff-Gabriel et al. (2012) and Combiths et al. (2019) provided investigations into the relationship between the phonological and morphological components of words ending in the speech sounds and morphology two children with co-occurring SSD and DLD could not produce. The present study continued to investigate the line of complexity established by Seeff-Gabriel et al. (2012) and Combiths et al. (2019) by working on target words that had both complex phonology (in the form of WFC) and complex morphology (in bound morphemes). The researcher also wished to include the methods of Tyler et al. (2003)'s simultaneous approach to maximise the level of phonological and morphological input that can be provided to a child, which was not investigated in Seeff-Gabriel et al. (2012), who investigated targets in an alternating intervention pattern, and Combiths et al. (2019), who investigated targets in a phonological intervention only. As this is a novel approach, the present study also analysed the morpho-phonological intervention's feasibility and whether the morpho-phonological intervention could be effective in a clinical context. The feasibility of the study asks, 'can this work?' The efficacy of the study asks, 'does this intervention work?' Therefore the research questions were:

1. For children with speech and language difficulties, does selecting targets that include phonologically and morphologically complex components of WFC and past tense –ed and 3S words and using a combination of speech and language interventions in each session result in improvements in the targeted speech and language errors?
2. Does the approach lend itself to clinician-friendly administration in its recruitment of participants, data collection and outcome measures, design procedures, the practicality of implementation, integration into the current intervention system(s), and intervention adaptability?

It is hypothesised that this approach, hereafter referred to as the morpho-phonological intervention, will improve the speech and language skills targeted. This hypothesis was formed on the basis that children in the simultaneous speech and language condition in Tyler et al. (2003) improved in their phonology and morphology, and the participant in (Combiths et al., 2019) experienced mild to moderate gains in phonology and mild gains in morphology in a language sample. It is also in line with the efficacy of complexity approaches, such as the evidence that incorporating target words with three-element clusters can result in more broad improvements in a child's phonology than singleton clusters (Gierut, 1999), and using words with complex morphology results in more significant improvements and broader generalisation of morphology (Van Horne et al., 2017). It was also hypothesised that the morpho-phonological intervention would be feasible based on the successfully reported administration of intervention in Seeff-Gabriel et al. (2012), Combiths et al. (2019), and Tyler et al. (2003).

Method

Ethics

Ethics approval for this study was obtained from the University of Canterbury Ethics Committee. The letters of approval have been attached as Appendix 3 and 4. The researcher sought guidance from the Kaiārahi (cultural guide) for the College of Science to collaborate on recruitment, assessment and intervention procedures if Māori participant(s) were recruited. Following this collaboration process, The Ngāi Tahu Consultation and Engagement Group were consulted to ensure the culture and well-being of Māori participants were safeguarded through culturally aware and responsive practice. The letter of response from the Ngāi Tahu Consultation and Engagement group has been attached as Appendix 5.

Study Design

Single-Case Designs

The study utilised a single-case design (SCD) with experimental and control skills. SCDs are a practical research method in clinical fields often applied in speech and language research due to disorders (such as co-occurring SSD and DLD) having a low prevalence across the general population. SCDs can establish the existence and strength of a relationship between an independent variable (i.e., an intervention) and the dependent variable (i.e., the intervention outcome measures) (Horner & Spaulding, 2010). SCDs receive criticism for their small sample and effect sizes, resulting in difficulty applying study results to the wider population studied. In speech and language pathology research, SCDs allow for more in-depth discussions of the effects of interventions on individuals rather than group effects. The population of interest being studied may not yield the appropriate numbers to be included in a group study with the required statistical power (Odom et al., 2005), and individual treatment effects can be lost when looking at group analysis (Horner et al., 2005). SCDs ensure that participants are not negatively impacted by control groups where there is a lack of intervention, often seen in randomised controlled trials (RCTs). SCDs provide each participant with an intervention condition while also recording control measures to strengthen the research quality and confirm experimental control over the dependent variable (Schiavetti et al., 2011). SCDs can be designed to investigate variables such as treatment intensity, outcome measures, and intervention activities, with comparatively more adaptability than RCTs. They allow readers to analyse the size of the observed effect rather than statistical significance, which is more relevant in clinical fields (Rvachew, 1988). Even if RCTs can be completed investigating morpho-phonological intervention for children with co-occurring SSD and DLD, SCDs are an important step in evaluating an intervention (Byiers et al., 2012).

Study Phases

This study involved three phases. The first stage was an assessment of speech and language skills, which included standardised assessments and pre-treatment probes of potential targets. The purposes of assessment were to describe the participant's speech and language characteristics pre-treatment, establish control behaviours prior to intervention and to identify the speech and language goals to be targeted during the intervention. The second stage was the morpho-phonological intervention, which aimed to improve the participant's speech and language skills. The third stage was the administration of the post-treatment probes (the same measures used in pre-treatment testing). The study was conducted between August and December 2020.

The experimental dependent variables were a) changes in speech sound accuracy in WFCs /vs/ and /sht/ and b) changes in the use of targeted language forms past tense –ed and 3S. The control measures were a) stability of the non-targeted speech sound production of word-initial /r/, and b) stability of the use of non-targeted pronouns.

Feasibility Analysis

The study utilised a feasibility analysis described by Gadke et al. (2021) (Figure 5). The development of models describing the dimensions of feasibility intervention research has occurred in medical and occupational health. Models include the feasibility of medical research by Bowen et al. (2009), the feasibility of occupational research by Tickle-Degnen (2013), feasibility of psychology research by Orsmond and Cohn (2015). This work guided the development of a ten-dimension model for feasibility studies in intervention research by Gadke et al. (2021).

Figure 5

Intervention feasibility dimensions and research questions. From (Gadke et al., 2021).

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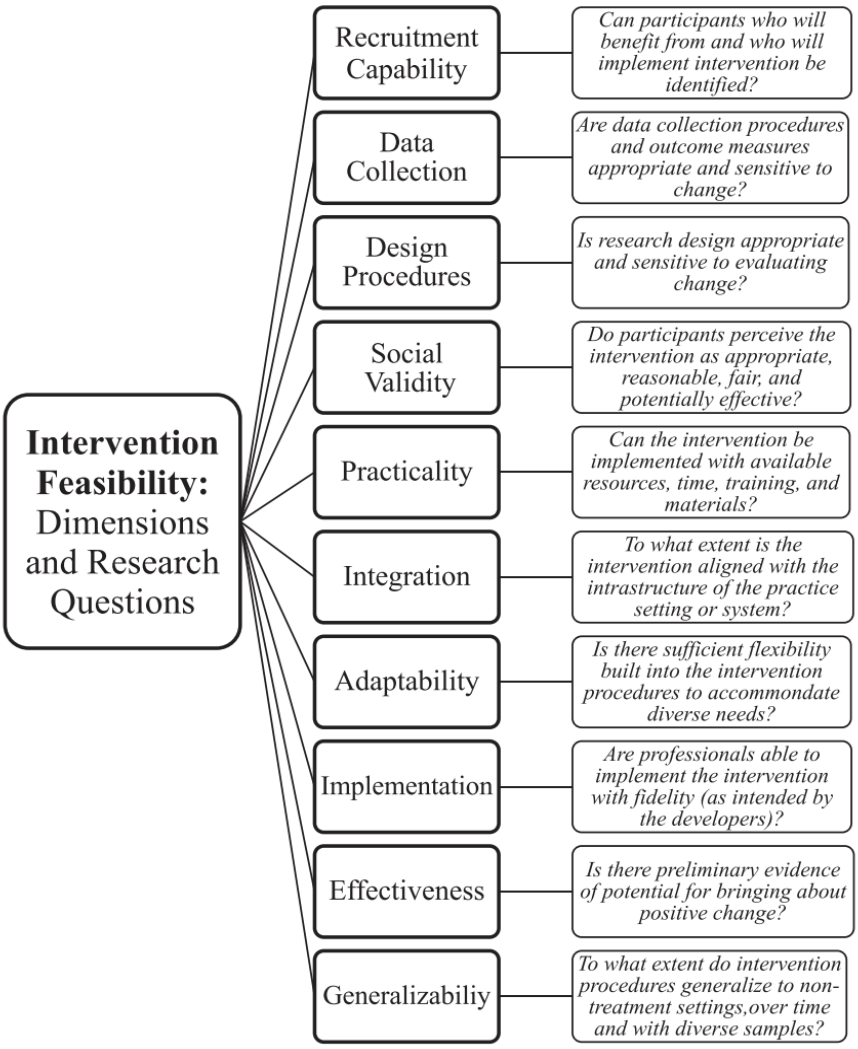


The ten dimensions consist of: *recruitment capability*, the researcher's ability to recruit appropriate participants to their study; *data collection*, the methods in which outcomes are designed and measured; *design procedures*, the methods in which the study is conducted, for example, single-case designs, and how these are employed, for example, AB phase designs, where baseline phase A is established before intervention phase B is administered (Engel & Schutt, 2016); *social validity*, the appropriateness of the morpho-

phonological intervention, described by the participant, their whānau (family), and those administering the intervention*; practicality,* how factors such as the time and resources impact the administration of the morpho-phonological intervention*; integration,* the intervention's ability to be accepted into already existing systems, and whether practitioners would be willing to change their current practices for a new intervention; *adaptability,* the ability of the morpho-phonological intervention to be modified to fit situations not tested in the research environment, for example, a different dosage amount; *implementation,* the adherence of the morpho-phonological intervention to the research design, and how this is applied in the clinical context; *effectiveness,* whether promising results can be investigated further in larger-scale early- or late-efficacy studies; and *generalizability,* how the intervention outcomes translate from the research environment to more naturalistic settings. Gadke et al. (2021)'s model will be used for this thesis's following feasibility analysis due to its relevance and application in interventions in the speech and language pathology field.

Feasibility of the Present study. Each of the ten dimensions established by Gadke et al. (2021) can be interchangeably examined in feasibility studies depending on their applicability; that is, not all ten dimensions need to be examined to determine a study's feasibility. Gadke et al. (2021) suggest that recruitment capability, data collection procedures, design procedures, and implementation are fundamental to analysing fidelity. In the present study, analysis of social validity, practicality, effectiveness, and generalisability have been excluded. Social validity should be addressed in future feasibility or early efficacy studies of the morpho-phonological approach to allow participant and whanau (extended family) perspectives to be incorporated into research findings. Questions relating to practicality and generalisability were answered in the adaptability domain. Questions relating to effectiveness were answered in the data collection procedures domain.

Participant Selection Procedure

Recruitment

Recruitment was achieved through the University of Canterbury Speech and Hearing Clinic. Recruitment pathways included identifying children from the caseload of children being seen at the Speech Clinic, identifying children from the Speech Clinic waiting list, or recruited via advertisement. The inclusionary criteria for participants in this study included:

a) children be aged between three-years-zero-months and four-years-11-months at the time of recruitment
b) children present with difficulties in both speech and language
c) speech characteristics including WFC reduction (deletion of a consonant sound from a two-sound blend in word-final position, for example, ‘left' becomes 'let', FCD, where 'cat' becomes 'ca-', and omissions (where 'red' becomes 'ed')
d) language characteristics including expressive language difficulty with finiteness markers such as past tense -ed and plural -s
e) No known biomedical causes for speech and language difficulties
f) English the main language spoken at home

Participant

The pseudonym 'Alex' has been assigned to the participant to protect his identity. Alex's whānau provided written consent for their child to participate, and Alex completed a written assent form. After the study, Alex was given a book, and his whānau were given a $30 petrol voucher.

Case History. A case history was obtained from Alex's Mother. The case history included asking relevant questions about his medical history, milestone development, social and education information to inform the researcher of any essential details of Alex's history prior to attending the research study.

Alex was four-years and 11-months old at the start of the study. Alex is of Māori and Pākehā (New Zealand European) ethnicity and spoke English. Alex lives at home with his Mother, Father, and older sister, who is nine-years-old. Alex started primary school during the initial assessment phase and enjoyed this, although he had difficulty transitioning to the longer days. Alex was reported to have a great relationship with his family and is a social young boy. Alex had been more shy than typical since starting school and spent most of his time with his sister. At preschool, Alex had many friends and would spend his time with them.

Alex had a history of speech and language difficulties. At 24 months, Alex used approximately 15 words, was not combining words, and used a range of phonological processes. Two SLTs had seen Alex prior to the intervention study, at the end of 2018 and the beginning of 2020, with both focusing on treating language. Following the two intervention blocks, Alex improved his language abilities, including increasing his vocabulary size and putting words together into sentences. However, he continued to have some difficulties with language morphology relative to age-matched peers post-intervention. Alex did not receive therapy for his speech sound difficulties, as his language difficulties took precedence. His speech was primarily intelligible, and he was able to express his thoughts, wants, and needs clearly. There were no concerns about Alex's development outside of his speech and language skills. Alex had a history of ear infections when he was younger but had not had any ear infections in the year prior to the intervention study. Alex had been seen by an audiologist when he was four-years-old, and his hearing was within normal limits.

Pre-Treatment Assessment

Standardised Assessment. To determine Alex's speech and language characteristics before the intervention phase, Alex completed an assessment battery which included standardised assessment and probe tasks created by the researcher.

Speech. Alex continued to present with difficulties producing speech sounds following his two blocks of prior language intervention. Alex's speech was assessed using the Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd et al., 2002). The DEAP assessment is a standardised norm-referenced formal assessment used to identify children's speech sound production abilities, including children's ability to produce specific speech sounds (articulation) and phonological patterns. The assessment involves showing children pictures of objects and asking the child to name them. This assessment is used for children aged three to seven. The Phonology Subtest was administered with Alex. During the assessment, Alex used the following phonological processes, which were compared to norms established by Grunwell (1981):

- Gliding: producing /r/ as a /w/, such as 'wain' for 'rain'. Alex consistently glided all productions of /r/ to /w/. This phonological process is typical for children of Alex's age.
- Fronting: producing /sh/ as a /s/, such as 'seep' for 'sheep'. Alex consistently fronted his /sh/ sound to a /s/ sound, and his voiceless /th/ sound (as in ‘thumb’) to a /f/. This phonological process is not typical for children of Alex's age.
- Cluster reduction: deleting a consonant sound in a cluster, such as 'wid' for 'wind'. Alex inconsistently reduced his clusters at the start and end of words. This phonological process is not typical for children of Alex's age.

- Stopping: producing a continuous sound as a short sound, such as 'dun' for 'sun'. Alex consistently stopped his voiced /th/ sound (as in 'this) to a /d/. Alex also stopped his /v/ to a /b/ sound in word-final clusters, producing 'globes' for 'gloves'. This phonological process is not typical for children of Alex's age

Alex was scored on his percentage consonants correct (PCC) and percentage of vowels correct (PCV), used to create a percentage phonemes correct (PPC) score. Alex's PPC score was 78.3%. PPC scores and a child's age are used to gain standard scores. A standard score below 7 indicates the presence of a speech difficulty. Alex's PCC score was 78.3%, which gave him a standard score of 3. Alex's PCC score, standard score, and use of phonological processes indicated he has a mild phonological disorder. Alex's speech was mostly intelligible to familiar and unfamiliar listeners in naturalistic connected speech samples. He did not appear to become frustrated by his speech sound difficulties during the assessment.

Language. Alex's expressive vocabulary was assessed using the Expressive One-Word Picture Vocabulary Test – 4 (EOWPVT-4) (Martin & Brownell, 2011). The EOWPVT-4 is a standardised, norm-referenced assessment used to assess a person's ability to name, in a word, objects, actions, and concepts, to determine their word generation skills. The assessment involves showing pictures of objects, actions, and concepts and asking people to name them. A score of 85 to 115 indicates a child's word recognition and generation ability is typically developing. Alex's standard score was 99, which indicated that he did not have difficulty with his expressive vocabulary.

Alex's language was assessed using the Clinical Evaluation of Language Fundamentals – Preschool 2 (CELF-P2) (Wiig et al., 2004). The CELF-P2 is a standardised norm-referenced formal assessment used to identify children's language ability. These

assessment areas include morphology (word forms, such as plural –s in 'cats' or past tense –ed in 'walked'), syntax (sentence structure), semantics (the meaning of words), and pragmatics (social skills). The CELF-P2 looks at children's receptive language (the ability to understand and interpret language information) and expressive language (the use of language). The assessment involves showing children pictures of objects and concepts and asking them to respond to questions, either by pointing (receptive language) or answering verbally (expressive language). This assessment can be used for children between the ages of three-to-six-years old. The Core Language Subtest was administered with Alex, which aims to identify the presence of a language disorder. It consists of three tasks: one receptive sentence structure task (where children listen to a sentence and match this to a picture); and two expressive tasks (word structure, where children are asked to complete a sentence) and expressive vocabulary tasks (where children are asked to label pictures of people, objects, and actions). Each task is scored, with the raw scores and child's age used to calculate standard scores. Each subtest score is combined to calculate the Core Language score.

A score below 7 indicates the presence of language difficulties. During the receptive sentence structure task, Alex received a standard score of 13, indicating he had above average receptive language abilities (measured by his ability to listen to and interpret language information). During the expressive word structure task, Alex received a standard score of 7, which indicated he had borderline difficulties in his ability to mark word morphology. Alex had difficulty using pronouns (him/her), plurals (cats), third-person singular –s (walks), regular past tense –ed (climbed) and irregular past-tense (fell). During the expressive vocabulary task, Alex received a standard score of 11, which indicated he did not have difficulties labelling and naming objects. The three tasks' scores were combined and analysed to inform on the nature of Alex's language difficulties.

According to the CELF-P2 manual, a standard score of 85 or below (one standard deviation below the mean) on the Core Language Subtest indicates DLD. Alex received a score of 102, which was in the average range. However, Alex presented with multiple errors in expressive grammatical morphology, a feature most often associated with DLD, scoring one standard deviation below the mean on this subtest (Word Structure). Along with his difficulties with expressive phonology, these difficulties had a functional impact on Alex's ability to communicate with unfamiliar conversational partners, a key diagnostic feature of DLD. Alex was five-years-old at the time of assessment and had just begun formal schooling. Given his age and mild severity, a diagnosis of DLD is queried at this stage, pending assessment of his progress over the next year at school to determine whether or not his difficulties with language learning are ongoing (Bishop et al., 2017).

Study Setting and Procedures

Procedure

The researcher is a newly qualified SLT and had experience providing assessment, intervention, and support to children with co-occurring SSD and DLD. Three Speech and Language Pathology students in their third year of professional study carried out the pre-assessment phase. The students were involved in a clinical placement working with children with speech or language disorders and had prior experiences using speech and language assessment tools preceding their involvement in the study. Students were trained by the researcher in the assessment procedures and were required to sign confidentiality agreements to safeguard the participant. Assessment and intervention sessions took place at the University of Canterbury Speech and Hearing Clinics in a clinic room. Sessions were audio and video recorded via an internally installed microphone and camera, situated in the clinic rooms at all times. Sessions were recorded to enable the researcher to watch the sessions live and to complete treatment fidelity. The study was designed to consist of two pre-assessment

sessions, 16 intervention sessions twice a week for eight weeks (total of 19 hours), and one post-assessment session. Alex required three pre-assessment sessions lasting two and a half hours total, attended 13 of 16 intervention sessions lasting one hour each over 14 weeks, and one post-assessment session lasting half an hour, equating to 16 hours of direct contact.

The researcher supervised each assessment session to ensure procedures were administered correctly, and the researcher was on hand to provide support to the students and participant if necessary. The researcher completed the intervention and post-assessment phases.

Pre-Treatment Probe Tasks

Alex participated in probe tasks designed by the researcher. When administering assessment with children with co-occurring SSD and DLD, careful interpretation must be taken if a child produces a word such as 'plays' /pleɪz/ as 'play' /pleɪ/. Did the child omit the final consonant because they cannot produce the /z/ phoneme or do not mark plurals? The first question can be answered by analysing words that include speech sound errors devoid of complex morphology. For example, the word 'buzz' includes word-final /z/ that is not a plural. If a child can produce 'buzz' but cannot produce 'plays', the issue lies in the child's morphology, not phonology. However, if a child cannot produce 'buzz' or 'plays', how do we know when there is no language impairment involved? The probe tasks were designed to allow the researcher to identify when Alex was making a speech-based error and making a language-based error. The probe tasks measured Alex's performance on the following forms:

1. Morpho-phonologically complex (MPC) words, where target words included WFCs and word-final morphology, such as past tense –ed 'mined' and 3S 'cooks'. The MPC probe tasks used words that were not targeted during the intervention but did contain the same WFC and morphology combination targeted during the intervention.

2. Phonologically related words, where target words included WFCs, but not word-final morphology (PR), such as ‘fact’.
3. Morphologically related words, where words included word-final morphology, but not word-final clusters (MR), such as past tense –ed ‘played’ and 3S ‘draws’.
4. Control words (phonological and morphological forms not targeted during the intervention sessions).

The structure of the CELF-P2 and Test of Expressive Grammar Impairment (TEGI) (Rice & Wexler, 2001) directions and guidelines was used to guide tasks to probe the use of past tense -ed, 3S targeted in the intervention, and a pronoun control. The structure of the New Zealand Articulation Test (NZAT) (Moyle, 2005) was used to create a phonological control task. The words used in the probe tasks were chosen specifically by the researcher to test phonological and morphological forms not found in the standardised assessment measures of the CELF-P2, DEAP, and TEGI.

Past Tense –ed Probe. Images were presented to Alex showing a person or object completing a variety of activities. The images showed the person or object ending a task. The research assistants gave Alex information about the task, “I am going to show you some pictures of people doing things. Then I am going to ask you about what they just did.” When showing the first image, the research assistants cued Alex by saying, “S/he is …” (e.g. ‘skipping’). The research assistants then showed the second image and cued, “now sh/e is done. What did s/he just do? s/he…” (target word = skipped). The research assistants used rising intonation to cue Alex that he needed to finish the sentence. A 'correct' score indicated Alex was able to use the past tense –ed form correctly. An 'incorrect' score indicated Alex could use the correct base word, for example, 'walk', but could not inflect this with the past

tense –ed form, for example, 'walked'. An 'unscorable' score indicated Alex used a word that was not prompted, for example, producing 'stop' when prompted to produce 'rushed'. The assessment consisted of 15 MPC words, five PR words, and five MR words.

Third Person Singular –s Probe. Images were presented to Alex showing a person or object completing a variety of activities. The research assistants gave Alex information about the task, “I am going to show you some pictures and ask you to tell me what each person does.” When showing the first image, the research assistants cued Alex by saying, “the girl likes to bake. Each day, she…” (target word = bakes). The research assistants used rising intonation to cue Alex that he needed to finish the sentence. The assessment consisted of 15 MPC words, five PR words, and five MR words.

Phonological Control Probe. The researcher created a Phonological Control probe to function as a measure of Alex's speech ability in a sound that would not be targeted during the intervention. Following an analysis of Alex's DEAP results, the /r/ phoneme was chosen as a robust phonological control measure. Its speech characteristics (for example, manner and placement) are unlike the characteristics of the target speech sounds /v/ and /sh/. Therefore Alex’s /r/ productions would not be expected to improve following intervention. Alex consistently glided his /r/ to a /w/. /r/ Images were presented to Alex showing a person or object starting with the /r/ sound. The research assistants gave the following instructions to Alex: “I am going to show you some pictures. I would like you to tell me what the pictures are called. Sometimes I might ask you to say the word again if I did not hear it”. The research assistants followed the hierarchy of prompts if Alex could not name the picture spontaneously:

- Point to the specific part of the picture, e.g. wrist. Prompt with “what is this part here?”
- Use a semantic cue, e.g. “it is where you wear a bracelet or a watch”.
- Use a sentence completion cue, e.g. “your hand is connected to your…” (wrist).

The research assistants were instructed not to use forced-choice questions, e.g. “is it van or car?’, and to not use phonemic cues, e.g. “it starts with /w/”or “it is a ssss…” If Alex could not name the picture correctly, the research assistant named the picture with the target word, said an intervening sentence without the target word in it, and then reprompted him for the target word. For example, “It is a radio. You listen to music on it. What is it?” If Alex could not name the picture correctly after several prompts, the research assistants could use imitation.

Pronoun Control Probe. The researcher created a Language Control probe to function as a measure of Alex’s language ability in a language element not targeted during intervention. Following analysis of Alex’s CELF-P2 scores, pronouns were chosen as a robust language measure. Pronouns do not include inflection morphology, as the target 3S and past-tense –ed forms do. Therefore Alex’s pronoun production would not be expected to improve following intervention. Alex was assessed on his ability to mark five classes of pronouns. These were: *subjective personal pronouns*, where the pronoun is the subject of the verb, for example ‘she’, ‘they’; *objective personal pronouns*, where the pronoun is the object, for example, ‘him’, ‘them’; *possessive personal pronouns*, where the object belongs to the pronoun, for example, ‘yours’, ‘hers’; indefinite pronouns, non-specific pronouns, for example ‘no one’, ‘everyone’; and *reflexive pronouns*, the subject and the object are the same, marked by –self, for example, ‘herself’, ‘themselves’. The order in which the pronouns

occurred on the assessment was determined by typical acquisition patterns described in Owens (2014). Images were presented to Alex to show a person or object completing a variety of activities. The research assistant gave Alex information about the task, “I am going to show you some pictures and say some things about them. I want you to help me by finishing some of the things I say.” The research assistant pointed to the relevant items and cued Alex by saying, “This is Jonny, and this is his friend Matilda. Finish what Jonny says. Jonny said to her, ‘that jacket is yours, and this jacket is...” (target response = mine). Pronouns were chosen for this task, following an analysis of Alex's CELF-P2 scores. Alex was shown 12 images and asked to finish the therapist's sentence, requiring him to use a pronoun. Correct scores indicated that Alex was able to use the correct pronoun. Incorrect scores indicated that Alex used a pronoun, but it was not correct in the context given. An ‘unscorable’ score indicated Alex did not use a pronoun in response to the prompt.

Treatments

Focused Language Stimulation

Language stimulation strategies were the most commonly cited language intervention across the intervention literature for children with co-occurring SSD and DLD (Lederer, 2002). FLS is a language intervention favoured widely by SLTs due to its functionality and level of enjoyment for the child. FLS is a play-based intervention where target words and grammatical structures are administered to a child using auditory bombardment. The play-based setting creates a functional environment where children hear a high frequency of accurate models of words and phrases with the aim to improve their acquisition and use of language. Target words are chosen, and the intervention agent (usually an SLT or a parent/member of the child’s whānau) manipulates the environment to facilitate

conversations about these words by choosing the toys or activities the child engages with. The child leads the activity through what they are interested in interacting with and is not required to respond to the utterances or actions of the SLT or parent. Intervention is effective regardless of whether a child responds verbally (Finestack & Fey, 2013). However, evidence suggests children learn target words faster when they produce them during the intervention (Weismer et al., 1993). FLS utilises *indirect language strategies* (ILS) (Paul et al., 2018), the structured modelling of language in various contexts. ILS are commonly used in parentese, where adults communicate with young children at a slower pace, in shorter sentences, and with simpler vocabulary, with increased intonation and exaggerations (Owens, 1996). ILS strategies are used during FLS with a structured administration and at a higher frequency than in natural environments. ILS increase the amount of target vocabulary information the child hears by providing correct semantic (meaning) and syntactic (grammar) information or novel utterances. ILS strategies include self and parallel talk (where the therapist comments on their and the child's actions); imitation; expansions and extensions (adding semantic and syntactic information to the child's utterances), and build-ups and breakdowns (increasing and decreasing the number of words spoken in similar sentences).

The administration of FLS recommends target words be nouns, verbs, adjectives, and prepositions, which can be represented easily, reflect the child's interests, and do not contain consonant blends. The straightforward representation of words gives children the tools they need to develop their communication skills without placing excessive demand onto their cognitive load (the amount of information a person's working memory can process) (Paas & Van Merriënboer, 1994). The variety of criteria for FLS target words leaves a clinician with a wide range of flexibility in selecting target word options. As the current intervention project was interested in investigating an MPC approach, all target words were relational verbs (past

tense –ed and 3S) and had WFCs. The researcher strived to select activities that were of the participant's interest but was limited by the range of potential target words.

The researcher administered the procedures of FLS (including the use of ILS) according to the guidelines provided by Lederer (2002) and Paul et al. (2018). Adherence to the guidelines was evidenced by the treatment fidelity results discussed later in this thesis. A list of the target words is provided in Appendix 6. The researcher aimed to administer target words at a frequency of nine words per minute, using the flowchart and frequency analysis suggested by Alt et al. (2020) that enables a clinician to calculate how many productions are needed, depending on the duration of the session and the number of different target words in the session.

Minimal Pairs

Minimal pairs is a speech sound intervention used with children with phonological impairments to teach them phonological rules (McLeod & Baker, 2017). A minimal pair is "a set of words that differ by a single phoneme, where the difference is enough to signal a change in meaning" (Barlow & Gierut, 2002). For example, the words' bake' and 'make' are minimal pairs, as they differ in their initial phoneme. Within the intervention studies included in the literature review for children with co-occurring SSD and DLD discussed in this thesis, minimal pairs was the most common intervention for speech errors, used in conjunction with auditory awareness and drill-play.

There are two approaches to minimal pairs, both described in Williams et al. (2010); *meaningful* minimal pairs (MMP) and *perception production* minimal pairs (PPMP). PPMP involves the same methods as MMP, with an additional two steps in the middle stages of intervention. MMP begin with *familiarisation*. The therapist and child talk about the target words. For example, the therapist may say, 'if you have flour, eggs, and sugar, you can make

a biscuit. When you have done that, you bake it in the oven'. When the child is familiarised, they are instructed to *listen* to what word the therapist asks them and *pick up* which one they think they said. The therapist gives feedback following their response. For example, 'pick up the picture with make. (Child picks up make). Great listening, that card says make. Pick up the picture with bake. (Child picks up make). Make? The word I said sounds like make, but it is different. Listen again, pick up the picture with bake'. The final stage is *production*. Essentially, the roles in *listen and pick up* are reversed, where the child asks the therapist to pick up a card. In this stage, the child's phonological system is challenged, as they must produce a contrast between the two words (at least one of which has a phoneme the child produced in error) to reduce semantic confusion. For example, '(child asks for make) Make! I know what you mean. (Child asks for make but means bake. Therapist picks up make, child indicates this is incorrect). I am not sure what you mean. Do you mean make or bake?'

PPMP intervention also begins with familiarisation and listen and pick up. PPMP differs from MMP by including *word imitation* and *independent naming* stages. In word imitation, the therapist gives auditory models and articulation instructions, where the child must listen to how the therapist produces each word and accurately respond. Word imitation continues until the child reaches approximately 90% accuracy. In independent naming, the child is then asked to produce the words without a model.

PPMP was chosen as the phonological intervention because it provided the participant with the opportunity to practise the target words' production. The application of PPMP in the present intervention study differed from the methods outlined by Williams et al. (2010) in how target words were administered and contrasted with each other. As mentioned, traditional minimal pair words consist of two words which carry entirely different meaning, such as make and bake. As the present intervention's target words had complex morphology and phonology, finding minimal pair words that carried entirely different meaning was

impossible. For example, one of the target words was the past tense –ed word ‘pushed’. There exists no minimal pair word for ‘pushed’, other than the present tense ‘push’. Therefore, target word pairs consisted of the base word and either past tense –ed or 3S inflection. The use of morphologically complex words also led to differences in how the target words were administered. The researcher was required to use additional cues to set up a linguistic context. For example, when targeting past tense –ed ‘pushed’ and its present tense form ‘push’, the researcher used tense cards to explain when the person is ‘doing’ the action, they use the word ‘push’, and when they are ‘done’, they use the word ‘pushed’. The researcher would use the tense cards to create the phonological contrast and explained, “This card (pointing to prompt card) means he is doing the action right now. That means the word (pointing to minimal pair contrast) is ‘push’. This card (pointing to the prompt card) means he is done with the action. That means the word (pointing to target word) is ‘pushed’”. When targeting 3S ‘dives’ and its first-person ‘dive’, the researcher used pronoun cards to explain when they or the participant complete the action, they use the word ‘dive’, and when another person completes the action, they use the word ‘dives’. The researcher would use the pronoun cards to indicate the –s inflection and explained, “this card (pointing to researcher or participant prompt card) means that you or I am doing the action right now. That means the word (pointing to minimal pair contrast) is ‘dive’, as in ‘I dive, or you dive’. This card (pointing to animal prompt card) means that he or she is doing the action right now. That means the word (pointing to target word) is ‘dives’, as in ‘he dives, or she dives’. Although adaptations were made to the way the target words were administrated, the researcher followed the PPMP approach's steps and used the cues to indicate semantic confusion, for example, “dive? The word I said sounds like a dive, but we use dive to talk about what I am doing or what you are doing. I asked you to point to what he or she does.”

Shared Stories

Shared stories is a language and literacy intervention that involves an intervention agent (such as an SLT or member of the whānau) reading a book with a child, making comments on what the child is interested in on a page (McCauley & Fey, 2006). The interventionist provides a rich back and forth conversation about the book, following the child's lead, guided by dialogic reading (DR) strategies. These strategies are known as PEER and CROWD, found in Table 2 (Blom-Hoffman et al., 2006; Cohrssen et al., 2016; Flack et al., 2018; Whitehurst et al., 1994).

The use of book reading facilitates language understanding and is often but not exclusively used as a transitional activity, rather than targeting specific skills. Books for the shared stories intervention in the current study included either morphological or phonological target words, but not MPC words. That is, the target words had either past tense –ed and 3S morphology or had word-final /v/ and /sh/. Each week, the book's focus was matched to the morphology of the FLS portion of the session. For example, sessions 1 and 2 focused on past tense –ed, therefore books were chosen for their inclusion of past tense –ed, and in sessions 3 and 4, books included 3S. Opportunities for speech sound productions of target sounds were utilised in all books.

The inclusion of storybook reading aims to build on the literacy skills of the child in this project. Children with co-occurring SSD and DLD are more likely to have literacy difficulties than children with isolated SSD or DLD and TD children. These difficulties are more strongly predicted from their language skills than their speech skills (Hayiou-Thomas et al., 2017; Nathan et al., 2004; Peterson et al., 2009; Sices et al., 2007).

Table 2

Dialogic Reading (DR) Strategies Descriptions and Examples from Zevenbergen et al. (2003). Copyright 2003 Taylor and Francis. Reproduced with Permission

DR Strategy		Description	Example
CROWD	Completion prompts	Fill-in the-blank question	"When it rains we use our…?"
	Recall prompt	Questions that as a child to recall a detail from the book	"What did Lucy do when she was scared?"
	Open-ended questions	Statements that prompt the child to talk about the book	"Now you tell about this page."
	Wh-questions	Who, what, where, when, why, how questions	"What colour is the ball?"
	Distancing prompts	Questions that ask the child to link events in the book to their own life experiences	"You travelled on an airplane like Harry, where did you go?
PEER	Prompt	Reminding the child to identify items in the book and talk about the book.	"Look at this page, what is that called?"
	Evaluate	Statements that praise correct answers or correct the child's incorrect responses.	"Yes that is right, the dog is brown."
	Expand	Repeating what the child says and providing additional information	"Yes, that is a dog. It is called a German Shepard."
	Repeat	Encouraging the child to repeat their response	"Say that again. What did you call that animal?"

Morpho-Phonologically Complex Targets

Following the assessment of Alex's speech and language skills, target sounds and words were selected that included his speech sound errors and language difficulties. Alex presented with speech sound difficulties producing word-final /v/ and /ʃ/, and these were selected as his target sounds. Alex presented with the greatest difficulty in understanding and

using past-tense –ed and 3S, as measured by his scores in the CELF-P2 and pre-test probes, and these were selected as his language targets. His speech and language targets were combined to select target words that combined WFC /vs/ in 3S words, for example, ‘drives’, and WFC /sht/ in past-tense –ed words, for example, ‘pushed’.

Each session lasted for 60 minutes. Sessions were divided into three 20-minute sections, with the three sections dedicated to a) the phonological component (PPMP), b) the language component (focused language stimulation), and c) storybook reading (using PEER and CROWD strategies). Table 2 describes the approach and targets for each session.

Table 3

Target Schedule

Session	***Minimal Pairs***	***Focused Language Stimulation***	***Shared Stories***
1, 2, 5, 6, 9, 10, 13	Speech target: /vz/ Language Target: 3S	Speech target: /sht/ Language Target: past tense -ed	Past tense -ed
3, 4, 7, 8, 11, 12	Speech Target: /sht/ Language Target: past tense -ed	Speech target: /vz/ Language Target: 3S	3S

Data Analysis

Descriptive comparisons of the differences between pre- and post-treatment probe scores across the experimental and control behaviours were chosen as the data analysis method for this study. This was to determine the strength of the relationship between the intervention and the outcome measures (Kratochwill et al., 2010; Lane & Gast, 2014). Descriptive comparisons are often utilised in SCDs due to the small sample size of participants, as data is easily interpreted and readers can see detailed information on each participant (Portney & Watkins, 2008).

Treatment Fidelity

An independent rater analysed a random selection of 20% of intervention sessions to establish the quality of treatment implementation. The rater was a qualified SLT with more than five years of clinical experience. The rater was skilled in using the intervention methods (PPMP, FLS, and shared storybook reading) and was trained to analyse the treatment fidelity quality and quantity checklists. The treatment fidelity template is included in Appendix 5. The rater was provided access to the recordings with time information removed and was therefore blinded to the order the sessions occurred. The independent reviewer was given access to the recordings for three days and could review the recordings as many times as required in this period. The independent reviewer could adjust the speed of the videos. Regarding the quality of sessions, the independent rater identified that each of the three morpho-phonological intervention sections was almost totally implemented as described by the treatment fidelity quality checklist. The rater identified the PEER strategy's repetition stage was consistently left out of each of the three randomly selected sessions. During FLS, the independent rater identified the researcher used target words at a frequency of 4.2 to 5.1 times a minute, for an average of 4.7 words per minute. This target word frequency is 50% less than the target frequency calculated as suggested by Alt et al. (2020). Although the researcher did not achieve their target dosage, the frequency of 4.7 words per minute during a 20-minute language intervention is in line with dosage reported in research such as Rice et al. (1994) and Solomon-Rice and Soto (2014), with children in both studies increasing their expressive vocabulary. Aside from the omission of repetition strategy and lower target word frequency, every other described speech and language strategy was included across the sessions according to the outlined intervention protocol. A full list of the described speech and language strategies can be found in the treatment fidelity template. Regarding the quantity of speech and language productions, the independent rater and the researcher scored

the same 20% of sessions for productions. Inter-rater reliability was calculated using the following formula:

$$\frac{\text{total number of agreements}}{\text{total number of agreements + the total number of disagreements x 100}}$$

Inter-rater reliability for language quantity was 96.3%. Reliability for speech quantity: clinician opportunities was 88%. Reliability for speech quantity: client accuracy (correct/incorrect responses) was 91.6%. These results indicated a high level of treatment fidelity.

Results

The study sought to explore the effectiveness and feasibility of a speech and language intervention for a child with co-occurring speech sound disorder and language difficulties. Alex's response to the morpho-phonological intervention was measured using pre- and post-treatment probe tasks and speech sound data during sessions. Feasibility was analysed using dimensions from Gadke et al. (2021)'s feasibility protocol.

Pre- and Post-Treatment Probe Assessment

Third Person Singular –s Probe

During pre-treatment testing, a 3S probe assessment was administered to Alex. Results are reported in Table 4. Alex correctly responded to 9/25 test items, a 40% accuracy rating. Alex responded to 5/25 (20%) of test items incorrectly. Eight of the 25 responses (32%) were unscorable, and Alex did not respond to 3/25 (12%) of test items.

During post-treatment testing (Table 5), Alex scored 23/25, a 92% accuracy rating. Alex's performance on the post-treatment probe is an accuracy increase of 156% compared to his pre-treatment probe performance. Alex responded to 1/25 (4%) incorrectly, and 1/25 (4%)

Table 4

3S Pre-Treatment Probe Task Results

Word Form		***Correct***	***Incorrect***	***Unscorable***	***No response***
MPC	Raw Score	3/15	5/15	6/15	1/15
	Percentage	20%	33.3%	40%	6.7%
PR	Raw Score	3/5	0/5	1/5	1/5
	Percentage	60%	0%	20%	20%
MR	Score	3/5	0/5	1/5	1/5
	Percentage	60%	0%	20%	20%
Combined	Raw Score	**9/25**	**5/25**	**8/25**	**3/25**
	Percentage	**36%**	**20%**	**32%**	**12%**

MPC = morpho-phonologically complex words, PR = phonologically related words, MR = morphologically related words

Table 5

3S Post-Treatment Probe Task Results

Word Form		***Correct***	***Incorrect***	***Unscorable***	***No response***
MPC	Raw Score	13/15	1/15	0/5	1/15
	Percentage	86.7%	6.7%	0%	6.7%
PR	Raw Score	5/5	0/5	0/5	0/5
	Percentage	100%	0%	0%	0%
MR	Score	5/5	0/5	0/5	0/5
	Percentage	100%	0%	0%	0%
Combined	Raw Score	**23/25**	1/25	0/25	1/25
Percentage	Percentage	**92%**	4%	0%	4%

Alex did not respond to. The increase in Alex's correct scores shows that Alex improved markedly in his ability to use 3S on the probe measures.

An evaluation of Alex's responses to each test item was conducted. During the pre-treatment assessment, Alex correctly responded to 3 out of 5 of the MR words. Incorrect responses were due to Alex not responding to the test item according to the testing procedure, resulting in a no response mark and responding with a response that was not prompted, resulting in an incorrect mark. These results contrast with the 15 MPC words, of which Alex also responded to 3 correctly. That is, Alex had a 20% accuracy rating when being tested on MPC words but a 60% accuracy rating on MR words. The only observable difference in these words is the lack of WFC in the MR words. Therefore, he may have had more difficulty producing 3S words when they included WFC, resulting in Alex omitting the –s phoneme. During the post-treatment assessment, Alex's one incorrect and one no response mark came from two MPC words. Therefore, post treatment Alex was able to produce PR and MR words with 100% accuracy in the probes and combine complex phonology and morphology correctly 86.7% of the time in MPC words.

Past Tense –ed Probe

During pre-treatment testing, a past-tense –ed probe assessment was administered to Alex. Results are reported in Table 6. Alex's combined score (MPC, PR and MR) was 2/25**,** an 8% accuracy rating. Alex responded to 6/25 (24%) of test items incorrectly (that is, using the correct base word without the correct inflectional morphology). Unscorable responses made up 17 of the 25 test items (68%) (that is, Alex responded with a word that was not prompted).

During the post-treatment testing (Table 7), Alex's combined score was 3/25, a 12% accuracy rating. Alex responded to 18/25 (72%) of test items incorrectly, and 4/25 (16%) of

Table 6

Past Tense –ed Pre-Treatment Probe Task Results

Word Form		***Correct***	***Incorrect***	***Unscorable***
MPC	Raw Score	1/15	5/15	9/15
	Percentage	6.7%	33.3%	60%
PR	Raw Score	1/5	0/5	4/5
	Percentage	20%	0%	80%
MR	Raw Score	0/5	1/5	4/5
	Percentage	0%	60%	40%
Combined	**Raw Score**	**2/25**	**6/25**	**17/25**
	Percentage	**8%**	**24%**	**68%**

MPC = morpho-phonologically complex words, PR = phonologically related words, MR = morphologically related words

Table 7

Past Tense –ed Post-Treatment Probe Task Results

Word Form		***Correct***	***Incorrect***	***Unscorable***
MPC	Raw Score	1/15	12/15	2/15
	Percentage	6.7%	80%	13%
PR	Raw Score	2/5	1/5	2/5
	Percentage	40%	20%	40%
MR	Score	0/5	5/5	0/5
	Percentage	0%	100%	0%
Combined	**Raw Score**	**3/25**	**18/25**	**4/25**
	Percentage	**12%**	**72%**	**16%**

responses were unscorable. Alex's scores were separated into their word form categories to individually analyse his MPC responses, PR responses, and MR responses. Alex

demonstrated no change in his MPC and MR responses. Therefore, Alex experienced no significant change in his ability to mark past tense-ed following the morpho-phonological intervention, as measured by the probe tasks.

Alex did experience changes in the distribution of his responses as categories by the probe tasks. During pre-test treatment, Alex had a higher proportion of unscorable responses (60%) than incorrect responses (16%). Alex's unscorable responses may indicate he had difficulty following the assessment instructions. However, during the post-test assessment, Alex had a higher proportion of incorrect responses (72%) than unscorable responses (16%), indicating he was able to use the target word (for example, kick) but did not understand how to use inflectional morphology (for example, kicked).

An evaluation of Alex's responses to each test item was conducted to determine if there appeared to be a pattern of change. During Alex's pre-treatment assessment, the test items he responded correctly to were the MPC word 'washed' and the PR word 'last'. During the post-treatment assessment, Alex responded to his previously correct MPC test item 'washed' with the incorrect production of 'wash'. On both assessments, Alex responded to the PR test item 'last' correctly. During the post-treatment assessment, Alex responded to the PR test item 'fact' correctly, where previously he had given an unscorable response, and test item 'paused' correctly, where previously he had given the incorrect response of 'unpause'. Isolating the differences in Alex's responses during pre- and post-treatment reveals that Alex had a limited and unstable understanding and ability to use past tense –ed. This limited understanding is evidenced by his correct response to test item 'washed' during pre- but not post-treatment assessment, and his incorrect response to test item 'paused' during pre-treatment assessment, and correct response during post-treatment.

Another observation from the pre-treatment probe is that Alex responded to the MR test item ‘played’ with the past tense –ed word, ‘cleaned’, and MR test items ‘agreed’ and ‘cried’ with ‘stopped’. Despite Alex producing correct past tense –ed words for these test items, he was given an unscorable mark, rather than a correct mark, as the probe task was designed to assess his ability to mark or change a word from its progressive –ing to past tense –ed form, rather than observing his generic use of past tense -ed. Before the test items were administered, Alex was given two trial items where the clinician provided correct productions of how to mark past tense –ed when given the base word in a progressive –ing form. When interpreting Alex’s results, the researcher cannot be confident that he can apply the rules of past tense morphology. That is, Alex may have rote-learnt the words ‘cleaned’ or ‘stopped’ without understanding they are used to describe previous events. To be certain Alex does understand that ‘cleaned’ and ‘stopped’ are past tense –ed words, the researcher would have to administer them as test items in their progressive –ing form.

Phonological Control Probe

Alex was assessed on his ability to produce /r/ pre- and post-test to serve as a non-targeted phonological control. During both pre and post-treatment testing, Alex consistently used the /w/ sound in place of the /r/ sound for every test item. Therefore, Alex scored 0/10 on this task.

Morphological Control Probe

Alex was assessed on his ability to produce pronouns pre- (Table 8) and post-test (Table 9) to serve as a non-targeted morphological control. During pre-treatment testing, Alex scored 4/12 or 43.6% correct on this task. Alex responded to 5/12 (41.7%) incorrectly and did not respond appropriately to the prompt in 3/12 (25%) of test items.

Table 8

Pronoun Control Pre-Treatment Probe Task Results

Word Form		***Correct***	***Incorrect***	***Unscorable***
Subjective personal pronouns	Raw Score	0/2	2/2	0/2
	Percentage	0%	100%	0%
Objective personal pronouns	Raw Score	1/2	0/2	1/2
	Percentage	50%	0%	50%
Possessive personal pronouns	Raw Score	2/4	1/4	1/4
	Percentage	50%	25%	25%
Indefinite pronouns	Raw Score	1/2	1/2	0/2
	Percentage	50%	50%	0%
Reflexive pronouns	Raw Score	0/2	1/2	1/2
	Percentage	0%	50%	50%
Score	Raw Score	**4/12**	**5/12**	**3/12**
Percentage	Percentage	**33.3%**	**41.7%**	**25%**

Table 9

Pronoun Control Post-Treatment Probe Task Results

Word Form		***Correct***	***Incorrect***	***Unscorable***
Subjective personal pronouns	Raw Score	0/2	2/2	0/2
	Percentage	0%	100%	0%
Objective personal pronouns	Raw Score	1/2	1/2	0/2
	Percentage	50%	50%	0%
Possessive personal pronouns	Raw Score	1/4	3/4	0/4
	Percentage	25%	75%	0%
Indefinite pronouns	Raw Score	1/2	1/2	0/2
	Percentage	50%	50%	0%
Reflexive pronouns	Raw Score	0/2	1/2	1/2
	Percentage	0%	50%	50%
Score	Raw Score	3/12	8/12	1/12
Percentage	Percentage	25%	66.7%	8%

During post-test treatment (Table 9), Alex scored 3/12 or 25% of test items correctly. Alex did experience a change in his scores in incorrect and unscorable marks. During the pre-test assessment, Alex responded inappropriately to four of the 12 test items (for example, when prompted with 'they have some fruit to share. The fruit belongs to…' Alex responded with 'shopping' when the correct answer was 'them'. During the post-test assessment, Alex responded to only one test item without a pronoun ('the fire', when the correct answer was 'themselves'). Alex had a higher proportion of incorrect responses (8/12 incorrect during post-test assessment) than pre-test assessment (five of the 12).

Speech Sound Production across Sessions

Alex's speech sound accuracy was measured from scores taken from his performance during the PPMP activities across the 13 sessions. Alex's speech sound data has been divided into his productions of /vz/ and /sht/. The accuracy of Alex's productions has been graphed according to the support he was provided by the clinician and the complexity of productions. The two levels of support were imitation (when the clinician provided Alex with a model before his production) and spontaneous (when the clinician prompted or cued Alex for a production without using the target word). The two levels of complexity were word level, where Alex was prompted to produce the target word only, and phrase level, where Alex produced the target word within a word phrase such as 'I found a ___'. During the morpho-phonological intervention, the researcher decreased their level of support and increased the complexity of the context of target words required of Alex following analysis of his performance from both the previous and the present session. For example, when Alex achieved an appropriate level of success at imitation of word-level productions, the researcher may have required him to respond spontaneously or respond at phrase level. As moving up or down the speech intervention hierarchy is informed by Alex's performance within the session, multiple different complexities may have been targeted during each

session. That is, Alex may have responded to targets at both word and phrase-level during one session.

Descriptive analysis of the data reveals that Alex had a large variability in his accuracy across sessions at the different levels of support provided by the clinician and at the two levels of complexity. Alex's accuracy during productions of imitation of word-final /vz/ fluctuated between 83 to 95% (Figure 6). This data was based on a range of 12 to 19 production opportunities per session. Alex's scores for spontaneous productions of /vz/ at word level also fluctuated and were recorded between 82 to 85% (Figure 7), based on a range of 17 to 18 production opportunities per session. However, all Alex's percentage accuracy scores were reported at a threshold above 75, which is often considered to appropriate accuracy goal when targeting speech sounds (McKercher et al., 1995), as further improvements are likely to be made through generalisation and maintenance effects without having to target the speech sound directly.

Alex had stable productions of spontaneous /vz/ at phrase level with an accuracy of 71%, based on a range of 14 to 28 production opportunities (Figure 8). This is below the

Figure 6

Speech Production Accuracy: Imitation of Word Final /vz/

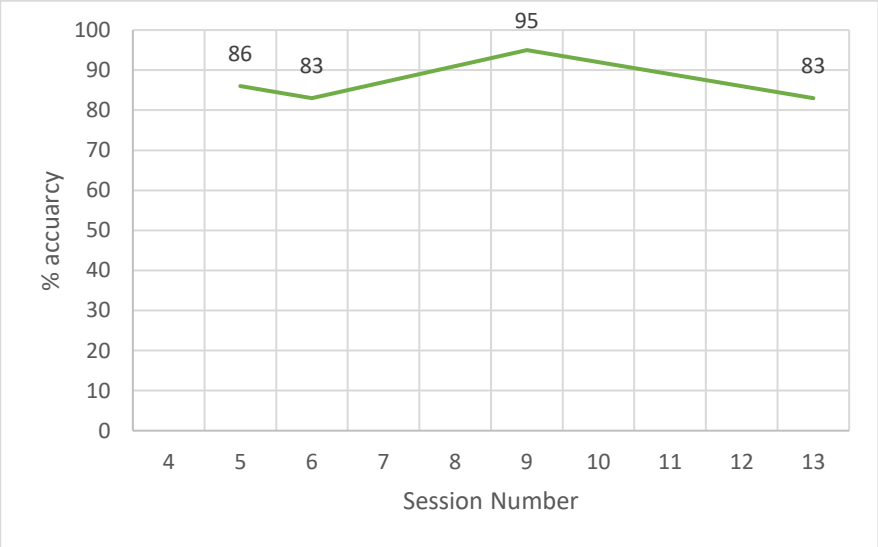


Figure 7

Speech Production Accuracy: Spontaneous /vz/ At Word Level

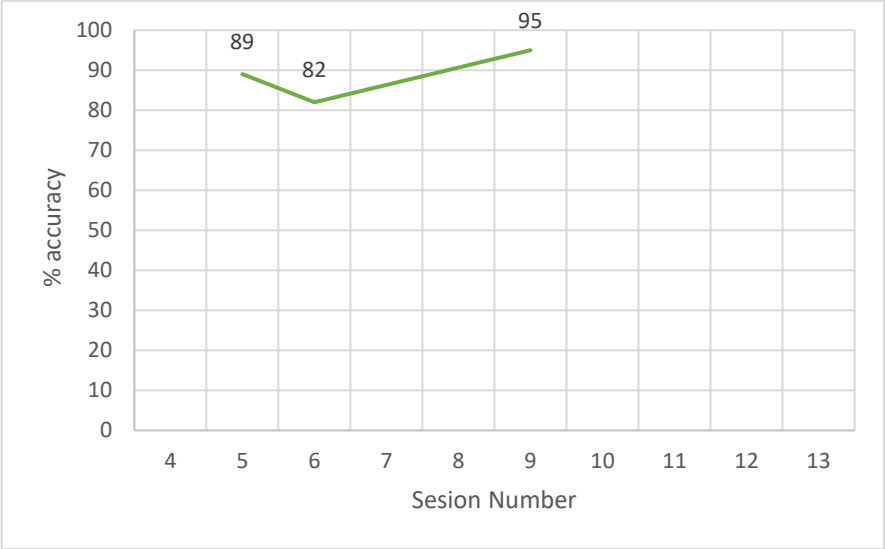
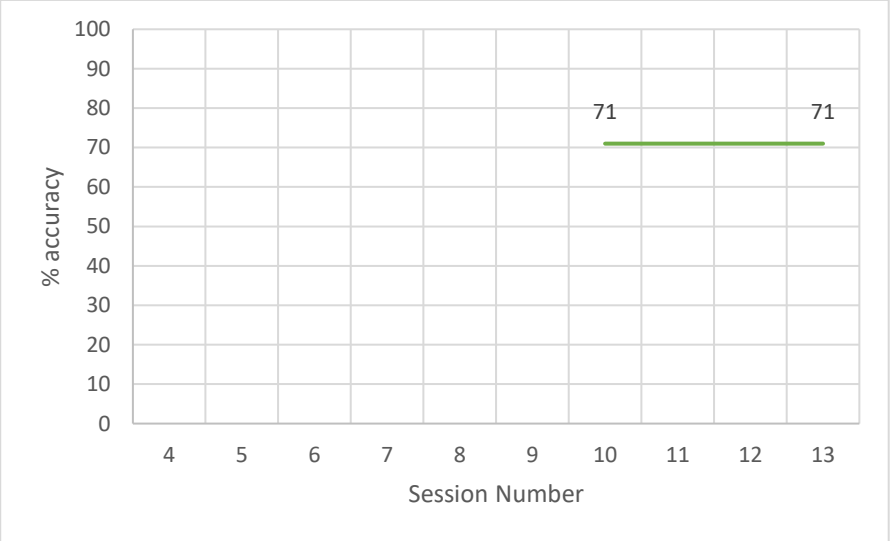


Figure 8

Speech Production Accuracy: Spontaneous /vz/ At Phrase Level



threshold as mentioned earlier of 75%, indicating that Alex may benefit from continued intervention at this level. Alex increased his production accuracy in word-final /sht/ following imitations from the clinician, recorded between 50 to 74%, based on a range of 6 to 19 production opportunities (Figure 9), and at spontaneous phrase level, recorded between 58 to 63%, based on a range of 36 to 41 production opportunities (Figure 10). This result is

Figure 9

Speech Production Accuracy: Imitation of Word Final /sht/

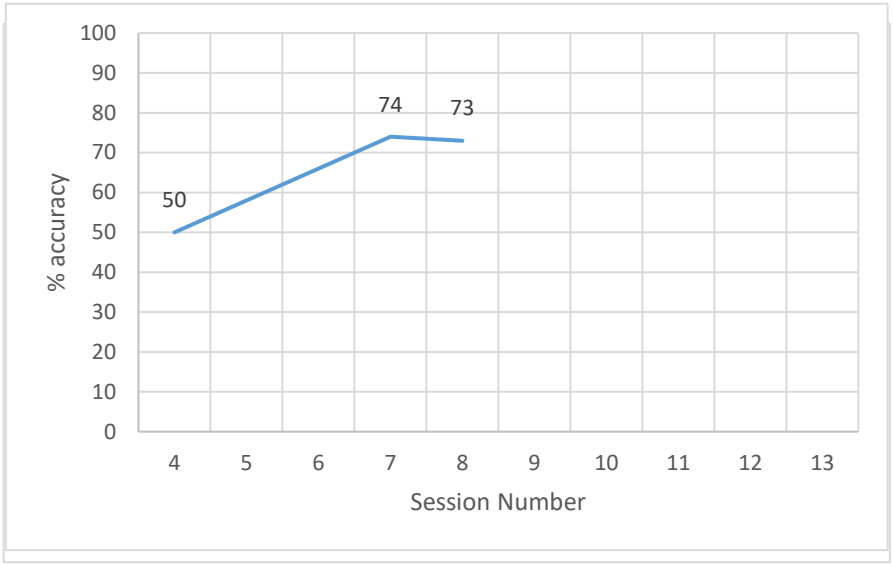
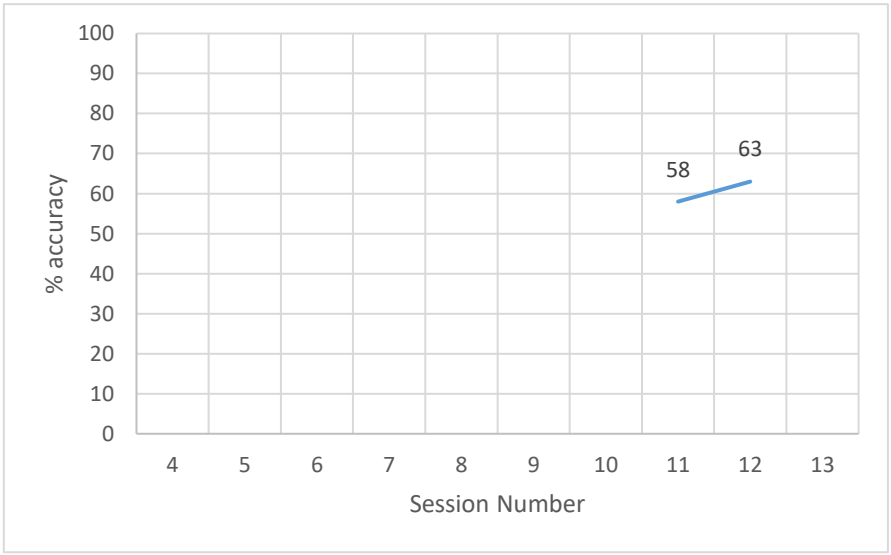


Figure 10

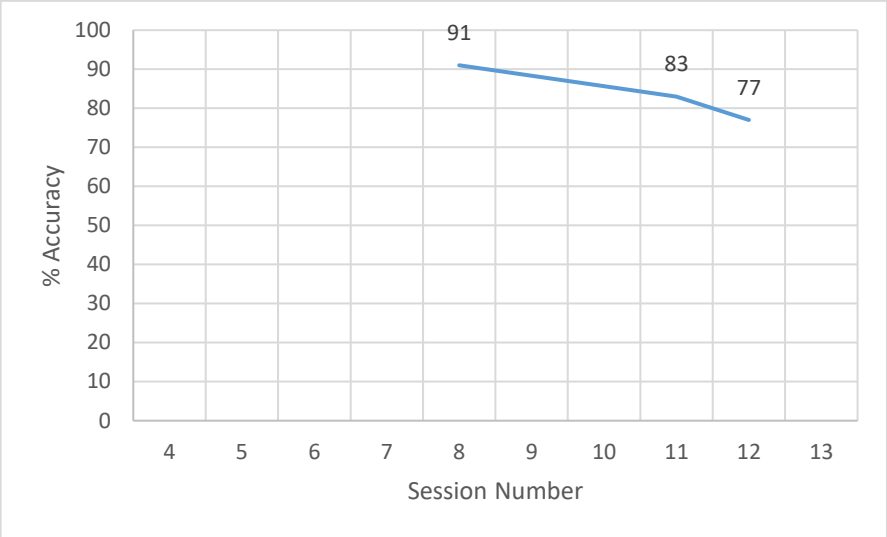
Speech Production Accuracy: Spontaneous /sht/ at Phrase Level



interesting given that Alex experienced a decrease in accuracy during spontaneous productions of /sht/ at word level, from 91 to 78%, based on a range of 11 to 13 production opportunities (Figure 11). However, as with Alex's scores on imitation of word-final /vz/ and spontaneous productions of /vz/ at word level, Alex's scores for spontaneous productions of /sht/ at word level were above the 75% threshold.

Figure 11

Speech Production Accuracy: Spontaneous /sht/ at Word Level



The following is a summary of Alex's speech sound performance, considering his improvements across the speech intervention hierarchy. Regarding word-final /vz/ productions, at the beginning of intervention, Alex was 86% accurate following imitations of the clinician's utterances. At the end of intervention, Alex was 71% accurate in spontaneous utterances at phrase level. Regarding word-final /sht/ productions, at the beginning of intervention, Alex was 50% accurate following imitations of the clinician's utterances. At the end of intervention, Alex was 63% accurate in spontaneous phrases.

Feasibility

Nine of the ten feasibility domains described by Gadke et al. (2021) were analysed to assess the present study's feasibility (Table 10). Social validity was excluded from the feasibility analysis as it was not formally assessed. Questions relating to adaptability and generalisability were incorporated into the practicality domain, and effectiveness was incorporated into data collection procedures. The feasibility analysis provided several questions that were addressed or should be addressed in the future to inform future studies using the same or similar morpho-phonological intervention.

Table 10

Feasibility Analysis

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
Recruitment capabilities	How accessible is the population? How can participants be recruited?	The prevalence of co-occurring SSD and DLD is between 2.3-7.4% (Shriberg et al., 1999; Tomblin et al., 1997), with an 11-75% chance of co-occurring deficits (Neam et al., 2019). This indicated that children existed in the population and could be recruited. The researcher recruited one participant to their study.	To advance to later efficacy and effectiveness studies, the researcher recommends recruiting multiple participants. Analysis of other intervention studies reveals that larger participant numbers can be achieved; Tyler et al. (2002) recruited 40 participants, and Fey et al. (1994) recruited 26 participants. The What Works Clearinghouse (2010) protocol recommends a minimum of three participants if three demonstrations of experimental effect can be achieved to meet evidence standards. Accessibility could be addressed by a population survey distributed to schools, The Ministry of Education (MOE), private practices, General Practitioners, and public advertising (for example, Facebook) to determine recruitment options and general interest in participation before an intervention study is rolled out.

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
Data collection procedures and Effectiveness	Are data collection procedures easily understood and implemented?	An assessment protocol document was provided to the research assistants (RAs), as well as the attendance of one compulsory training session The researcher was a newly qualified SLT with experience in administering speech and language assessment and intervention. The researcher created the data collection procedures, so therefore, understood how they were implemented. The RAs completed the assessment described by the researcher, measured through the research observing all sessions live and recording assessment results alongside the assistants.	The data collection procedures used could be easily incorporated into clinical practice due to their similarities to existing assessment batteries used to assess co-occurring SSD and DLD.
	How much time is needed to train intervention assessors/agents?	The training period occurred over three weeks before the intervention study to ensure the RAs felt prepared and comfortable administering the assessment. Training consisted of one hour-long discussion and practice session with the researcher and RAs, with opportunities to answer questions	The time provided to RAs was revealed to be appropriate by the correct administration of assessment measures and their confidence in doing so. This protocol is hypothesised to be feasible in a larger scale study or for qualified clinicians, as they would likely need

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
	Are the instructions sufficient? Will administrators need help administering session(s)?	and role-play scenarios, and a one-hour practice assessment session with a client not involved in the research study. Post-assessment debrief sessions with the researcher occurred following each assessment session to provide qualitative feedback to the RAs on their administration skills. RAs were paired together during sessions, one assistant administering and the other recording assessment data. The researcher observed all data collection sessions and was available to step into sessions as and when needed. Clinical Educators (qualified SLTs) were on hand as independent observers who could provide support and guidance to RAs.	significantly less time to prepare for administration of assessment.
	How much data is needed to draw meaningful conclusions?	The researcher collected data on the participant's ability to mark 3S and past tense –ed and the participant's speech sound production across sessions.	Now that the researcher has developed and tested the probe tasks and the morpho-phonological intervention, future SCED studies could follow the protocols outlined by The What Works Clearinghouse (2010) to ensure that researchers

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
	Do the hypothesised intervention mechanisms appear to have the predicted effects or show promise of effectiveness?	The intervention had predicted effects on Alex's ability to use 3S words, accurately produce WFC /sht/ at word and phrase level, and WFC /vz/ at word and phrase level as measured by scores above 75%. The intervention did not have the predicted effects on Alex's ability to use past tense – ed. However, given his improvement in 3S words, this indicates the intervention could be trialled on other forms of morphology.	can collect enough data before, during, and after an intervention to provide reportable results that meet evidence standards. This includes collecting baseline measures before the intervention and at least three points of experimental effect during the intervention period. This is hypothesised to be feasible in a larger scale study due to the increase in resources that would likely be available.
	What outcome measures are the most useful clinically and sensitive to intervention? Are the measures reliable?	The outcome measures were the post-intervention criterion-referenced probes of MR, PR and MPC words, pronouns and the /r/ phoneme. Reliability of measures could have been assessed through inter-rater reliability, where multiple raters independently analyse the administration of measures to determine the degree of agreement that measures were administered correctly. However, this was outside of the scope of this study. The outcome measures were guided by the	The researcher is confident that the outcome measures were effective at detecting change in Alex's performance because they were created using other reliable and valid assessment measures and were administered according to the outlined protocols.

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
		structure of previous formal assessments, using their protocols with test items specific to the research project.	
	Is there a practice effect?	Practice effects were assessed through control measures, which were speech and language targets that were not targeted during the morpho-phonological intervention. Practice effects were minimised by probe tasks being administered three months apart and using different assessors for pre- and post-test probe measures.	Although practice effects are challenging to determine, there is no evidence that they impacted the outcome measures' ability to detect an intervention change, as the participant experienced significantly more improvement in 3S productions than past tense –ed. In addition, no changes were noted in the control behaviours from pre to post-testing.
Design procedures	Is an SCD feasible?	Yes, SCDs are feasible, as evidenced by the administration of the present project.	The researcher recommends that future studies advance to the next phase in Fey et al. (2009)'s intervention research designs The results of this and similar studies support the intervention's potential and would be worth investing further time and resources into exploring the effects of a morpho-phonological intervention for children with co-occurring SSD and DLD.

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
Practicality, Adaptability and Generalisability	How frequently and over how long a period is an intervention likely to be necessary? Is it necessary to adhere to the rigid requirements?	Based on the results of this feasibility SCD, the frequency and dosage of sessions are likely to be effective with children like Alex, but more frequent sessions with a stronger routine could result in faster gains.	An additional block may have been needed to effect change in past tense –ed for Alex. Therefore, future studies could investigate the amount of intervention needed for children who present similarly to Alex or more severe. Variations in the number of sessions per week, and length of sessions, could be investigated. However, due to the extreme variability and complexity of these children's presentations, it is unlikely that one dosage amount would work for all children or in an amount that could be administered in every clinical setting. Larger-scale studies might compare dosages achieved in research settings to those in clinical settings to determine whether typical clinical conditions are sufficient.
	Do SLT's/ intervention agents have the resources to	Clinicians/research teams with access to the tools of motivating games, activities that facilitate morphology intervention, and books with speech or language targets and the ability to create resources for prompting	Researchers could address this question by providing a guide for the creation or sourcing of resources. Researchers could outline several activities that would be appropriate.

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
	implement the intervention?	target words could implement this intervention.	
	Are the tools needed for implementation universal?	The researcher had many resources for FLS available to them, but finding appropriate resources to facilitate the target words' use was challenging. Target words were often limited in the ways they could be represented, and due to their morphology, required more thought to be applied to their administration. For example, past tense –ed words needed to be administrated following an event which would require their use, for example, the crashing of a car to use the word ‘crashed’. However, once target words were selected and resources acquired, the researcher could easily alternate session activities and goals.	
	Do research teams have the skills and resources to conduct the study?	The researcher faced difficulties finding appropriate targets words, administering intervention with target words, and keeping motivation high with Alex. Difficulties finding targets was due to Alex’s speech	

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
		sound errors, pairing these with his morphological errors, and finding activities that allowed for naturalistic administration of target words. For example, targets needed to be 3S words ending in WFC /vz/and were able to be represented with a picture card and understood by a five-year-old. The researcher needed to devise a way to administer PPMP, where the two minimal pair words were with and without language morphology, described in this thesis's methods section. The administration of PPMP presented challenges in the 'listen and pick up' stage of the morpho-phonological intervention, as the researcher had difficulty interpreting whether Alex was correctly identifying the picture card by listening to the target word 'dive' or the pronoun 'I/you/she/he'. Alex also began to overgeneralise language productions, for example, 'I dives'.	
	Does the content and amount of	In this instance, the researcher delivered the intervention herself. However, a manual has	In future larger-scale studies, the manual combined with training is expected to be sufficient for SLT

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
	training support implementation?	been created to guide intervention protocols using the methods described by key researchers each of the intervention procedures; PPMP (Williams et al., 2010), FLS (Lederer, 2002) and shared stories (Whitehurst et al., 1994).	students to deliver the intervention with high treatment fidelity. SLTs may be able to deliver the intervention with no additional training as outlined in the manual. However, there are some challenges to overcome, such as sourcing target words, creating activities, and providing the correct feedback when both phonologically and morphologically errors occur or contradict one another (for example, when Alex produced 'I drives', knowing when to give speech versus language feedback)
	Can the programme be easily adjusted to fit across different settings, for example, school?	The researcher recommends that the morpho-phonological intervention is best suited for administration in a pull-out space with 1-on-1 support from an SLT due to the advantageous acoustics and degree of individualisation of programming required.	Future later-efficacy or effectiveness studies could assess the morpho-phonological intervention's ability to be implemented in settings outside of the research environment, for example, in school or at home.
Integration into existing systems	What is currently being implemented?	The three interventions utilised in the current study are amongst the most commonly used interventions for speech and language difficulties (Brumbaugh & Smit,	Future studies could investigate alternative speech and language intervention methods.

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
		2013; Ezell et al., 2000; Fey et al., 1994; Law et al., 2003; Tyler et al., 2002; Tyler & Sandoval, 1994). SLTs and students were already using the three intervention types in the present intervention study at the University of Canterbury Speech Clinic, where the research study was administered. Within one-to-one direct service delivery settings this intervention should integrate well into existing systems.	
	How does the present study fit into this practice?	The present research study used FLS and PPMP following their protocols while investigating unique complex target word combinations and simultaneously providing interventions. Therefore, the only changes needing to be made are in the target word selection. The storybook intervention was used following the usual protocols. However, book selection was made based on the target morpheme of the session.	As discussed, there were considerable challenges to implementing the morpho-phonological intervention with the restrictions of target words. However, if word lists and a corresponding package of resources based on the most likely final clusters and morphemes children have difficulty with were created, that this would facilitate facility implementation for future studies.

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
Implementation	Do activities lend themselves to frequent administration of intervention procedures? Is the optimal length of intervention phases acceptable to participants?	The researcher used their report of ease of administration to report on the activities ability to be frequently administered. When activities were chosen, they were able to be administered frequently. However, as the intervention progressed, the researcher found they needed to use more clinical skills to keep Alex engaged as he became familiar with activities and wanted to try something new. This may not be a characteristic of all research participants.	The researcher suggests incorporating social validity measures in future studies. Social validity can be measured in the form of a survey, interview, or Likert scale and completed with Alex, the whānau, and school staff (if involved).
	Are participants(s) engaged?	The researcher used her clinical skills to interpret Alex's level of enjoyment \and adjusted activities to ensure Alex remained motivated. The researcher could have used social validity measures to assess how Alex perceived the intervention and whether they found it enjoyable.	The researcher suggests that sessions take place in the morning or at a time when a participant(s) have the highest amount of energy. The researcher suggests that consistency is maintained in session times to ensure participants remain in an intervention routine.

Dimension(s)	**Questions addressed**	**How questions were addressed in the present study**	**How questions can be addressed in the future**
		The researcher found Alex highly engaged in activities when Alex was compliant and ensured that Alex had positive experiences during the morpho-phonological intervention regardless of their performance. Factors that contributed to Alex's difficulties engaging in sessions or session tasks included the time of day, general behaviour, and whether Alex's Mum was present at the session. These factors were managed by the researcher but could not always be controlled.	
	Is the treatment programme administered in a way that adheres to the predetermined procedures?	An independent reviewer observed 20% of sessions following a quantitative and qualitative checklist to determine whether the intervention agent administered intervention following the predetermined guidelines. The independent reviewer and researcher achieved 96.3% and 88% agreement on the language and speech quality checklist, indicating high treatment fidelity.	The researcher suggests future studies continue to complete treatment fidelity to ensure interventions are administered following the outlined protocols.

Discussion

The purpose of this study was to explore the feasibility and effectiveness of a morpho-phonological intervention that included phonologically and morphologically complex target words, using a combination of speech and language intervention strategies for a child with co-occurring speech and language difficulties. This study also provided an analysis of the feasibility of such an approach. It was hypothesised that this morpho-phonological approach would facilitate improvements in the speech and language skills targeted. The post-treatment probes revealed that the intervention was effective at improving Alex's ability to mark third-person singular –s. Alex improved his scores on the post-treatment 3S probe task from an accuracy score of 36% to 92%. The post-treatment probes revealed that the intervention was not effective for past tense –ed, as Alex received a score of 8% pre-treatment and 12% post-treatment, indicating minimal change. Session data indicated that Alex improved his ability to produce /sht/ in imitated word productions, increasing his percentage accuracy from 50% to 74% and WFC /sht/ in spontaneous phrases, increasing his percentage accuracy from 58% to 63%. Alex has stable productions of /vz/ productions at spontaneous phrase level (71% across sessions). Alex's productions of /vz/ in imitated and spontaneous words fluctuated, with imitated words achieving scores between 83% and 95% across sessions and spontaneous words, achieving between 82% and 95%. Alex's productions of WFC /sht/ in spontaneous words decreased in accuracy, from 91% to 77%. It was hypothesised that the researcher would identify barriers and facilitators to the intervention's administration. This discussion highlights the intervention study's key findings, comparing these to previously published literature and finally considers the feasibility of such an approach. This discussion also reports implications for clinical practice, limitations of the study, and future research suggestions.

Impact of Intervention on Speech and Language Performance

Impact on Speech Skills

The first variable, changes in speech sound accuracy in WFCs /vs/ and /sht/, was measured by analysing Alex's performance during the PPMP intervention activity. Across the 13 sessions, Alex improved his ability to produce /sht/ in word imitations and spontaneous phrases but had variable results for his productions of /sht/ in spontaneous words and all productions of /vz/. Alex did experience improvements for both WFC /sht/ and /vz/ across the speech intervention hierarchy, where he improved in /vz/ productions from 86% accuracy in word-level imitations to 71% accuracy in spontaneous phrases, and WFC /sht/ from 50% accuracy in word-level imitations to 63% accuracy in spontaneous phrases. Alex's improvement in his production of /sht/ mirrors the results found in Seeff-Gabriel et al. (2012) and Combiths et al. (2019), where the participants in both studies improved in measures of phonology following phonological interventions. However, his variable performance in /vz/ productions is not consistent with their findings. The target words in Seeff-Gabriel et al. (2012) were word-final singleton consonants (for example, 'bees'), as well as WFC (for example, 'books'). The differences in the present study's results and that of Seeff-Gabriel et al. (2012) could be due to their use of word-final singleton consonant target words and a traditional articulation approach. The participant would have had the opportunity to practice the /s/ phoneme without producing it in blends. This participant's ability to improve in /s/ during articulation therapy supports a hierarchical target word approach, where therapy is administered from easier to harder to produce sounds, as compared to the complexity approach investigated in this study. However, the participant's success with word-final /s/ productions did not generalise to initial and medial position or /z/ productions. The lack of generalisation may indicate that the participant required a phonological intervention, such as PPMP, to remediate his ability to learn and apply phonological rules.

Where Seeff-Gabriel et al. (2012) included both a speech sound and language intervention, Combiths et al. (2019) investigated the effects of a phonological intervention without an accompanying morphological intervention. The participant received a total of 14 hours of speech sound intervention across 14 weeks and had only one speech sound target, WFC /lps/. While Alex's total intervention time was 13 hours, Alex received approximately four hours and 20 minutes of speech sound intervention during the PPMP activity and had two WFCs targets, /vz/ and /sht/. It could be that the additional amount of time the participant in Combiths et al. (2019) spent in focused speech sound production tasks contributed to their improvements in the target WFC /lps/.

Alex's difficulties with his production of speech sounds could be due to several factors outside of his ability to perceive and produce speech sounds. In their discussion, Tyler et al. (2002) suggested that the amount of variability in the speech and language performance of children with co-occurring SSD and DLD could be attributed to the individual learning styles and personalities of the children. Alex exhibited difficulties in following some intervention procedures due to motivation and behavioural difficulties. Children have often reported that they enjoy the activities, games and stories they complete in speech and language therapy (Coad et al., 2020; Owen et al., 2004). Children have high levels of motivation when they are pursuing their own goals but need external drivers when completing goals set by another person (for example, an SLT), such as the reward of playing a game intermittently during therapy (Gilmore et al., 2015; Gurland & Glowacky, 2011). Alex expressed a preference for the FLS procedure of the morpho-phonological intervention as it was more intrinsically motivating. Alex could navigate through the activities how he wished, perusing his own goal or interest. During the PPMP portion, Alex had to do what was asked of him by the researcher, and more extrinsic motivators were needed to support Alex to complete his tasks. There was also a lack of routine in the scheduling and timing of sessions,

with some occurring after Alex had spent five hours at school (with a likely fatigue effect) and some sessions occurring during the school holidays in the morning where Alex was well-rested. Alex was more engaged with the morning sessions and maintained his focus for almost the entire hour of the session. Alex had difficulty maintaining his focus during afternoon sessions and would need consistent breaks throughout the session or high clinician support levels to be redirected back to the task.

Although speech sounds were not directly elicited during the FLS language activity during the present intervention project, the same words used in the PPMP portion were used in the FLS portion, giving Alex increased exposure to them. Intervention studies have investigated the indirect effects of language intervention on speech performance, with most researchers finding language intervention can facilitate gains in speech (Hoffman et al., 1990; Matheny & Panagos, 1978; Tyler et al., 2002), but this is not consistently replicated (Tyler & Sandoval, 1994; Tyler & Watterson, 1991).

Alex's consistent performance during the phonological control probe task assessing /r/ supports the notion that Alex's speech sound performance in targeted final clusters was not due to natural maturation factors but was due to the morpho-phonological intervention.

Impact on Language Skills

The second variable, changes in targeted language forms past tense –ed and 3S, was measured through Alex's performance on the probe tasks. Alex exhibited a significant improvement in his ability to use 3S morphology following the morpho-phonological intervention but had no change in his ability to use past tense –ed morphology. His improvements in 3S morphology are consistent with reports by Tyler et al. (2003) and Bellon-Harn et al. (2004). However, his lack of change in past tense –ed conflicts with this research and Seeff-Gabriel et al. (2012). Alex had an unstable and inconsistent representation

of past tense –ed at the end of intervention. One factor that may have influenced Alex's difficulties acquiring past tense morphology is the difficulty representing past tense during language interventions such as FLS. The researcher used ILS strategies to recast Alex's productions or provided commentary on Alex's actions. This meant the researcher had to wait until an action was completed before they could provide language facilitation. Alex had often moved on to perform another action or was more focused on what he was doing than the researcher's utterances. For example, one of the target words used was 'crashed'. When playing with a train set, Alex would crash the trains. When the researcher commented on Alex having 'crashed' the trains, he was already moving the trains around the track again. Therefore he may not have been piecing together the action he had just performed ('crashed') and the clinician's utterance. This is compared with 3S morphology, where the researcher provided models of the target words while Alex was performing them. The researcher provided Alex with prompt cards to illustrate the difference between past tense –ed and present tense and would often write '-ed' during the session activity when Alex would omit the morphology to indicate he was missing the final sound. However, it may be that Alex needed more direct instruction on the use of past tense –ed, such as the strategies used in Seeff-Gabriel et al. (2012), where the interventionist used visual cues of coloured blocks to show when something has occurred –ed is added to the end.

Feasibility

The feasibility measures were addressed through a subjective analysis conducted by the researcher. Although subjective analysis such as feasibility studies need to be treated with caution in scientific research (Jahn & Dunne, 2007), they provide an avenue for researchers to share their perspectives from their experiences and give suggestions to improve or progress to larger-scale studies (Fey et al., 2009). A ten-dimensional feasibility research model (Gadke et al., 2021) was used (Figure 4). A subjective analysis follows.

Feasibility researchers have adopted a 'traffic light' system to indicate features of a study that are ready for the next phase of investigation (green light), features that need to be improved before they can be administered in the next phase (yellow light), and features that may suggest research should not continue down its current path (red light) (Avery et al., 2017). A subjective review of the current study suggested that the following were "green light" features: recruitment capabilities; the ability to train research assistants to implement data collection procedures; the promise of effectiveness; control measures contributing to the lack of practice effects; feasibility of SCD studies in intervention research for children with co-occurring SSD and DLD; and the adaptability and integration of the intervention to current practice. A particular strength was the manual outlining data collection methods, which combined with training was successful in supporting the RAs in administering these tasks. If future research was to occur following this intervention procedure, the intervention is already clearly outlined.

'Yellow light' features of the present study included: the outcome measures, their reliability and validity, and how much data is needed to conclude; the effectiveness of the intervention compared to the hypothesised effects and over how long a period intervention is needed to be effective; the rigidity of intervention requirements; and the implementation of the morpho-phonological intervention. The researcher provided some suggestions to improve the reliability and validity of future research. One suggestion, and possibly the most important, is for future studies to conduct at the feasibility or early efficacy study level following the What Works Clearinghouse protocols (Kratochwill et al., 2010). For example, to recruit at least three participants and administering at least three measurements of the dependent variable at each phase. This ensures future studies meet the evidence standards and determine the relationship between the independent and dependent variables. Without following this protocol, researchers cannot be assured that a study's results can be applied to

other individuals who share the same characteristics as the participant(s) who experienced the independent variable.

Another suggestion concerns the practicality of the morpho-phonological intervention. The researcher found that combining phonological and morphological targets was the most challenging aspect of the morpho-phonological intervention. The researcher had to adapt the PPMP from its traditional implementation to allow for minimal pair contrasts between base words, such as ‘wash’, and its WFC bound morpheme words, ‘washed’. The researcher was able to implement PPMP in a method that allowed for this contrast. However, at times this method led to over generalisation of some productions. For example, Alex responded to one test item with ‘I drives’ in place of ‘I drive’ or ‘she drives’. Because PPMP was focused on his speech sound productions, the researcher gave feedback for the production of /vz/and then corrected the sentence's morphology. It may be that the provision of feedback on both the phonology and morphology of the word is overwhelming for a child to comprehend, which is especially important when considering children with co-occurring SSD and DLD’s deficits in phonological and verbal short-term and working memory (Alloway et al., 2009; Torres et al., 2020). Children with co-occurring SSD and DLD have a more limited processing capacity than children with SSD only or DLD only, where phonological and morphological information decays more rapidly (Gray et al., 2019; Nathan et al., 1998; Torres et al., 2020). Alex may not have been able to process both phonological and morphological feedback simultaneously, resulting in inaccurate representations of the speech sounds and over-generalisations of the morphology. The researcher suggests further investigation into phonological intervention methods that would facilitate productions of bound morphemes with WFC without overwhelming participant’s memory skills.

The added constraints of finding target words that contained the same combination of WFC and bound morphology created difficulties in selecting appropriate resources that

would allow natural and spontaneous use of these words in the FLS intervention. It was also difficult to find enough resources to ensure the participant remained motivated to complete the intervention tasks. Future research could create a guideline for selecting WFC target sound and bound morphology combinations and create ready-made resources to allow future intervention agents a more accessible implementation pathway.

The researcher identified no 'red light' features of the intervention design. The researcher deemed the morpho-phonological intervention, as it currently stands, to be feasible, as the intervention was created and implemented as planned, and Alex exhibited some improvement in his targeted speech and language skills. However, the above further developments to the intervention are recommended before the next research phase is undertaken, such as an early efficacy study (Fey and Finestack, 2011).

Implications for Clinical Practice

The results of this study have several implications for clinical practice. Although Alex's results were variable across his productions of WFC /vz/ and /sht/ and ability to use past tense –ed and 3S, he showed improvement in some measures, indicating that the intervention approach's basic tenets could be adopted in clinical practice. There is conflicting research in whether clinicians should take a hierarchical approach, where speech sound and language skills are targeted from easily-acquired or represented (for example, singleton consonants or nouns) to later-acquired (for example, consonant clusters and verbs), or a complexity approach, where intervention begins with later-acquired sounds and morphology (Gierut, 1999; Van Horne et al., 2017). This morpho-phonological intervention supports previous research by Seeff-Gabriel et al. (2012) and Combiths et al. (2019) regarding the feasibility of a complexity approach and that they can be beneficial for children with co-occurring SSD and DLD. However, interventions that include target words with complex

verb morphology and phonology may not always be suitable for children with co-occurring SSD and DLD. The use of MPC target words described in this project may explain why Alex experienced variability in his performance in the targeted speech and language skills. Although Alex was not assessed in his linguistic processing skills, it may be that he has underlying deficits in PSTM or verbal working memory. If Alex did have deficits in his ability to process phonological and morphological information, this may reduce his capacity to store and process feedback on the accuracy of his speech sound production and morphology. Clinicians should consider their client's ability to process and attend to phonological and morphological information before administering a complexity approach, especially for younger children.

Although there is no consensus on the most effective speech-language intervention for children with co-occurring SSD and DLD, for example, an indirect morphological narrative and phonological minimal pairs approach (Hoffman et al., 1990; Tyler & Sandoval, 1994), or a morphological and phonological storybook reading approach (Bellon-Harn & Credeur-Pampolina, 2016; Bellon-Harn et al., 2004), many morpho-phonological interventions incorporated the same or similar methods of facilitating speech and language production. For example, regardless of the phonological approach, intervention agents used speech modelling and prompting to provide accurate productions of target speech sounds and gave the children feedback on their production accuracy (Matheny & Panagos, 1978; Tyler et al., 2002; Tyler & Watterson, 1991). Regardless of the morphological approach, the intervention agents used repeated opportunities for children to listen to and practice words (Fey et al., 1994; Hoffman et al., 1990; Tyler & Sandoval, 1994). The strategies of the present morpho-phonological intervention aligned with other intervention methods that have been and are effectively used for children with co-occurring SSD and DLD (Hegarty et al., 2018; Law et al., 2017; Sugden et al., 2018). The results of this preliminary single-case study indicate that combining

phonological and morphological targets in the same word and activity is feasible. However, further research is needed to develop the intervention approach and determine its efficacy in an experimental study with multiple participants.

It can be challenging to predict how much intervention children will need to exhibit improvements in their speech sound production. These predicting factors can relate to the child, such as whether they present with co-occurring disorders such as DLD, and relate to the intervention, such as the morpho-phonological intervention dosage. For Alex, the variability in his speech sound production may have been influenced by his grammatical morphology as he not only presented with difficulties marking regular past tense –ed and 3S but also plurals and irregular past tense. Tyler et al. (2003) found around half of the variability in their 40 three- to five-year-old participants' phonological gains was explained by the relationship between their speech error consistency and morphological ability. That is, for half the participants, their language ability influenced their ability to improve in phonology. Although this was not replicated by Farquharson et al. (2020), who found for their 126 five- to eight-year-old participants, language difficulties did not impact their ability to improve their speech sound production. The variability in Alex's speech sound productions may also have been influenced by treatment factors, such as frequent breaks in session occurrence and no home practice. Across the intervention period, there were three weeks where Alex received no therapy, and his sessions averaged one per week, half the frequency aimed for by the researcher.

Limitations

The present study results should be interpreted with caution. This is due to a number of factors. First, the study investigated the intervention effects with one participant, Alex. The What Works Clearinghouse (Kratochwill et al., 2010) requires three participants to be

included in SCDs to meet the standards. Another factor limiting the intervention effect's certainty was the lack of repeated baseline measures and during-treatment probe measurements. Kratochwill et al. (2010)'s criteria for single-case experimental designs require three demonstrations of the experimental effect and at least three data points per phase to control threats to internal validity and ensure effects are replicable (Horner et al., 2005). Meeting these standards in future studies would increase confidence that the gains were due to the morpho-phonological intervention and that the results may generalise to other children with a similar profile.

The intervention data show promise of effectiveness as measured by comparing pre- and post-treatment probe assessments and speech sound production across sessions. However, maintenance and generalisation to other non-targeted speech sound errors and language morphology Alex had difficulty with were beyond the study's scope. Generalisation effects have been observed in previous research when targeting morphology that carries tense and agreement, such as 3S, as improvements were seen in non-targeted morphology that also carried tense and agreement auxiliaries (words such as 'is', 'are', and 'was') (Leonard et al., 2004). Previous research has observed maintenance effects such as the aforementioned morphological complexity approach by Van Horne et al. (2017). In their follow-up, Van Horne et al. (2018) found children in their 'hard-first' condition not only maintained their morphological gains on structured probes and narrative retellings but continued to significantly improve in these skills 50 days after their post-intervention assessment session, measured through language samples, compared to the 'easy-first' condition.

Future Research

Future research in morpho-phonological interventions for children with co-occurring SSD and DLD should investigate early efficacy studies on this approach to meet the What Works Clearinghouse protocols (Kratochwill et al., 2010).

A follow-up study that assesses the maintenance and generalisability of the gains made in intervention is an essential next step to establish whether a morpho-phonological intervention's effects are sustained over time and determine whether there are positive indirect effects on other phonological and morphological skills not targeted. Assessment of maintenance and generalisability would include administering assessment measures after the morpho-phonological intervention's conclusion to gather data on long-term maintenance skills, with some researchers following the performance of participants six months post-intervention (Broomfield & Dodd, 2011). The measurement of non-targeted skills is also essential to gauge the morpho-phonological intervention's broader impact on the child's linguistic system.

One element not explored in this study are the explanatory factors behind Alex's variable responses to the different components of morpho-phonological intervention for children with co-occurring SSD and DLD. For example, in the present study, why Alex improved in 3S, but not past tense –ed. Future studies could investigate whether certain types of language errors and certain speech error patterns are more amenable to change. For example, morphology such as 3S or error patterns such as substitutions may be more responsive to morpho-phonological interventions than past tense –ed or omissions.

Expanding the emergent literacy component of morpho-phonological interventions is also an important next step for an efficacy study. A shared stories activity that utilised DR reading strategies was included in the intervention to facilitate language understanding and

build connections to print. Future studies should look to include literacy and PA instruction as children with co-occurring SSD and DLD are at a higher risk for having difficulties developing their emergent literacy, for example, in word decoding, reading comprehension, and PA (Murphy et al., 2016; Pavelko et al., 2017; Skebo et al., 2013; Sutherland & Gillon, 2005; Tambyraja et al., 2020; Tambyraja et al., 2015), with language difficulties being a stronger predictor of literacy deficits than speech difficulties (Catts, 1993; Hayiou-Thomas et al., 2017; Lewis et al., 2011). Although they did not measure literacy or PA, Bellon-Harn and Credeur-Pampolina (2016) and Bellon-Harn et al. (2004) successfully implemented a storybook reading activity for children with co-occurring SSD and DLD that improved the children's speech and language skills. Tyler et al. (2011) included a PA programme in their intervention study, where participants in both their PA and speech sound and morphology and speech sound intervention groups improved in measures of speech, language, and PA skills. However, skills were more significantly improved in the directly-targeted group, PA skills in the PA group and morphology skills in the morphology group. Children with poor phonological processing skills have been shown to improve their reading and spelling abilities following PA interventions (Gillon, 2018) and shared story interventions (Crowe et al., 2004). Further investigation into the addition of shared stories and PA interventions is vital to inform whether their inclusion (either alongside or in place of phonological and morphological interventions) would yield significant improvements in the speech, language, PA and literacy skills for children with co-occurring SSD and DLD.

Conclusion

To the researcher's knowledge, this was the first study to investigate the feasibility of a morpho-phonological intervention that included phonologically and morphologically complex target words administered in simultaneous phonological and morphological intervention activities. The present study showed that this morpho-phonological intervention

could be effective for children with co-occurring SSD and DLD. Alex experienced considerable gains in his ability to mark third person singular –s but had no change in his ability to mark past tense. Alex improved his ability to produce WFC /sht/, increasing his production accuracy from 50% in word imitations to 63% in spontaneous phrases. Alex had variable results for his productions of WFC /vz/. However, he did improve from 86% accurate following imitations of the clinician's utterances to 71% accurate in spontaneous utterances at phrase level. Through subjective feasibility analysis, facilitators and barriers to the intervention project's administration were identified, and suggestions for future iterations of this line of research were provided. Further research into larger-scale single-case experimental designs investigating morpho-phonological intervention studies for children with co-occurring SSD and DLD is warranted to support SLTs to make better-informed decisions in the speech and language treatment of these children.

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Appendices

Appendix 1

Speech and Language Interventions for Children with SSD and DLD

Author/s (Year)	*Study Design*	*Participants*	*Intervention*	*Outcomes*
Matheny and Panagos (1978)	RCT group comparison	24 children aged 5-6 with SSD + DLD	Three groups: Group 1: Articulation intervention (PI) (Baker & Ryan, 1971) Group 2: Syntax intervention (LI) (Gray & Ryan, 1973) Group 3: Control (no intervention)	First direct intervention study in SSD + DLD intervention PI made more significant gains in phonology than LI and also made gains in language LI made more significant gains in language than PI and also made gains in phonology
Tyler and Sandoval (1994)	Pretest-posttest group comparison	Six children aged 3-4 with SSD and DLD	Three intervention groups: Group 1: Direct phonological based elicited imitation and minimal pairs approach (PI) Group 2: Indirect narrative language-based focused stimulation approach (LI) Group 3: Combination (P+LI)	PI and P+LI groups experienced a reduced frequency of phonological processes, increased MLU, and advancements in Brown's stages, with P+LI group having more significant improvements than PI group, as well as improvements in the use of plurals LI group had minor improvements in phonology and marked improvements in MLU and advancements in Brown's stages

Hoffman et al. (1990)	SCD with randomised intervention	Two children aged 4 (twins) with SSD + DLD	Two intervention conditions: Condition 1: Phonological approach (modelling and feedback) (PI) Condition 2: Whole language approach (meaningful story listening and recalling) (LI)	PI produced more outstanding gains in PCC and reduced phonological processes compared to LI LI produced more significant gains in language, including simple and complex sentences, reduced syntactic and verb errors, compared to PI, where language gains were not significant.
Tyler and Watterson (1991)	RCT treatment group comparisons	13 children aged 3-5 with SSD + DLD	Two intervention groups: Group 1: Phonologically based cycles approach (PI) Group 2: Language-based scripts approach (LI)	PI group made gains in PCC and MLU LI group made gains in MLU but regressed in PCC Participants in the LI group had more severe deficits than participants in PI, hypothesised to contribute to results
Fey et al. (1994)	RCT control group comparison	26 children aged 4-5 with SSD + DLD	FLS Three intervention conditions were investigated: Group 1: 10 participants completed a clinician-administered programme Group 2: 8 participants completed a parent-implemented intervention programme	No significant improvements in phonology in clinician and parent-led groups compared to control Significant gains in language in clinician and parent-led groups compared to control Gains in language were not correlated with gains in PCC Moderate to profound impairments in phonology does not impede significant gains in language

			Group 3: 8 participants completed delayed intervention (control)	
Bellon-Harn et al. (2004)	Pretest-posttest	Three children aged 5 with SSD + DLD	Use of cloze, expansions, and contrast word scaffolding procedures during storybook reading	Increases in PCC; decreased frequency of phonological processes (FCD, stopping, fronting) Increased phonemic and syllabic complexity in response to all scaffolding procedures Cloze and expansions resulted in increased complexity of semantic responses; no effect for contrast words
Bellon-Harn and Credeur-Pampolina (2016)	Pretest-Posttest group comparison	Two children aged 5 with SSD + DLD; 1 with consistent, 1 with inconsistent speech errors	Use of cloze, expansions, and contrast word scaffolding procedures during storybook reading	The participant with consistent errors responded to contrasts with correct productions; participant with inconsistent errors responded with revised but not always accurate productions Both children eventually showed equivalent responses to intervention
Tyler et al. (2002)	Pretest-posttest control group design	20 children aged 3-5 with SSD + DLD Seven children aged 3-5 as TD controls	Three groups: Group 1 and 2 complete one block of each approach Group 1: Phonology-first approach using auditory awareness, contrastive sound pairs, drill and	LF group produced a more significant change in morphosyntax compared to PF, and more significant changes in phonology compared to control PF group produced a more significant change in phonology compared to LF, but no change in morphosyntax

			naturalistic play, and PA (PF) Group 2: Morphology-first approach using auditory awareness, focused stimulation and elicited production (LF) Group 3: TD control	
Tyler et al. (2003)	Pretest-posttest control group design	40 children aged 3-5 with SSD + DLD Seven children aged 3-5 as TD controls	Five groups: Group 1: Phonology-first approach using auditory awareness, contrastive sound pairs, drill and naturalistic play, and PA (PF) Group 2: Morphology-first approach using auditory awareness, focused stimulation and elicited production (LF) Group 3: Alternating approach (week 1 PF condition, week 2 LF condition) Group 4: Simultaneous approach (PF and LF	After the first block of intervention, the most significant gains in morphology were seen in the LF group, followed by the alternating group, as compared with the control group Most significant gains in phonology seen in the LF group, followed by alternating, then spontaneous, as compared with control After the second block, children in the alternating group had the most significant gains in morphology, with no difference in the other three groups. No group differences in phonology were found.

			condition in the same session) Group 5: TD control	
Tyler et al. (2011)	Random assignment with matched pairs	30 children aged 3-5 with SSD + DLD	Two intervention groups: Group 1: Alternating PF+LF approach (as in Tyler et al., 2003) (MS/SS) Group 2: Combined PA and phonological approach (PA/SS)	Both MS+SS and PA/SS made gains in PA measures, finite morphemes, MLU, and PCC; groups had similar gains in speech accuracy measures Specific skills were favoured in the direct intervention approach; letter naming was superior in PA/SS, language measures superior in MS/SS
Seeff-Gabriel et al. (2012)	SCD	One child aged 5 with SSD + DLD	Combined morphological and phonological intervention at two times: Time 1: Phonological intervention targeting verb morphology Time 2: Phonological intervention targeting phonology (/s/) and morphology (plurals)	Following T1, improvements in regular (but not irregular verbs) Following T2, improvements in plurals and word-final /s/ accuracy
Combiths et al. (2019)	SCD	One child aged 5 with SSD + DLD	Direct phonological intervention targeting clusters in 3S real and nonwords	Variable improvements in phonology; moderate improvements in initial singleton sounds, mild improvements in initial and final clusters, and final singletons

		Nominal improvements in 3S and past tense, no improvements in plurals Growth in morphology in a language sample

RCT = Randomised Control Trial, SCD = Single Case Design FLS = Focused Language Stimulation, PCC = Percent Consonants Correct, AAE = African American English, FCD = Final Consonant Deletion, MLU = Mean Length of Utterance, TD = Typically Developing, PA = Phonological Awareness

Appendix 2

Summary of interventions used in literature for children with speech and language disorders.

Study	*Language Intervention(s)*	*Speech Sound Intervention(s)*	*Note(s)*
Matheny and Panagos (1978)	Programmed-syntax intervention, according to the Monterey Language Program (Gray & Ryan, 1973). Administration of program was not described in Matheny & Panagos (1978). The program was described in, who detailed the program focused on syntax and use of content and function words, with prompting and feedback on morphology, during storybook reading and conversational situations.	Programmed-articulation intervention, according to the Monterey Articulation program (Baker & Ryan, 1971). Administration of program was not described in Matheny & Panagos (1978). The program was described in Ginn (1976), who defined the program's three stages; establishment (acquisition of speech sounds), transfer (carryover of target phonemes to other contexts/speech sounds), and maintenance (stabilisation/generalisation). The program appeared to follow similar principals of the Traditional Articulation Approach (Riper, 1963).	
Tyler and Sandoval (1994)	Indirect narrative language approach utilising story retelling with focused language stimulation strategies such as expansions and recasting. The clinician and client read a story together. The client was asked to retell the story and was provided feedback, with the clinician	Perception-production Minimal Pairs (Tyler et al., 1987; Williams et al., 2010). Children were required to identify pictures corresponding to target sounds in minimal pair words (for example, sew and toe) and given opportunities to practice producing target speech sounds.	Also investigated a combination approach with indirect narrative language and perception-production minimal pairs administered in the same session

	modelling correct responses when the child produced an error.		
Hoffman et al. (1990)	Whole language treatment program, similar to the story retelling intervention in Tyler & Sandoval (1994), with the addition of the clinician providing specific requests for clarification, new events, or complexity of responses.	Minimal pairs, as previously described.	
Tyler and Watterson (1991)	Scripted story language treatment, similar to the story retelling intervention in Tyler & Sandoval (1994), with the addition of the clinician providing real or role-played scenarios relating to the story where the client can practice morphology utilizing clinician feedback, modelling and questioning.	Minimal pairs, as previously described. A cycles approach was also utilised to alternate speech targets weekly regardless of performance (Bauman-Wängler & Garcia, 2020).	
Fey et al. (1994)	Focused language stimulation (Cleave & Fey, 1997) and cycles, as previously described.	N/A	Investigated language approach three ways: clinician-implemented, parent-implemented, or delayed treatment.
Bellon-Harn et al. (2004)	Storybook reading therapy; similar to the story retelling intervention in Tyler & Sandoval (1994), with the addition	N/A	

	of clinician use of expansions (clinician providing more complete language content and form), cloze procedures ('fill in the blank'), and contrastive word pairs (minimal pairs).		
Bellon-Harn and Credeur-Pampolina (2016)	As in Bellon-Harn (2004)	N/A	
Tyler et al. (2002)	Morphosyntax intervention utilising focused language stimulation strategies (as previously described), auditory awareness (heightening awareness of targets), and elicited production (clinician providing opportunities for the client to use targeted speech sounds) (Cleave & Fey, 1997)	Phonological intervention utilising auditory awareness (listening to target words), conceptual activities (comparing and contrasting errored vs accurate speech sound production) (Howell & Dean, 1994), production practice, and PA activities (for example, sound identification).	
Tyler et al. (2003)	As described in Tyler (2002)	As described in Tyler (2003)	Also investigated alternating therapy (language intervention and phonological intervention administered in alternating weeks) and

			simultaneous (interventions administered in the same session).
Tyler et al. (2011)	Morphology intervention, as described in Tyler (2002), with the addition of auditory awareness activities and speech sound production practice during drill play and naturalistic activities.	Phoneme awareness with integrated speech sound production intervention; phonological error patterns were targeted through PA activities (Gillon & McNeill, 2007)	Speech sound intervention included in language condition and PA condition.
Seeff-Gabriel et al. (2012)	Morphological intervention including role play, auditory bombardment, judgement tasks (client judging whether clinician said an utterance correctly or incorrectly), and elicited production.	Traditional articulation-type intervention techniques (Riper, 1963)	
Combiths et al. (2019)	N/A	Two-phase drill-play format (Shriberg & Kwiatkowski, 1982) with explicit articulatory instruction, role play and collaborative storytelling.	Words used were complex in their phonology (clusters) and morphology (3S).

Appendix 3

Human Ethics Committee Letter of Approval (1)

UNIVERSITY OF CANTERBURY

HUMAN ETHICS COMMITTEE

Secretary, Rebecca Robinson
Telephone: +64 03 369 4588, Extn 94588
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2020/41

3 July 2020

Brooklyn Johnston
Psychology, Speech and Hearing
UNIVERSITY OF CANTERBURY

Dear Brooklyn

The Human Ethics Committee advises that your research proposal "Speech-Language Intervention for Children With Co-occurring Speech and Language Disorders" has been considered and approved.

Please note that this approval is subject to the incorporation of the amendments you have provided in your emails of 26th June and 3rd July 2020.

Best wishes for your project.

Yours sincerely

R. Robinson

pp.

Professor Geoffrey Rodgers
Deputy Chair
University of Canterbury Human Ethics Committee

Appendix 4

Human Ethics Committee Letter of Approval (2)

HUMAN ETHICS COMMITTEE
Secretary, Rebecca Robinson
Telephone: +64 03 369 4588, Extn 94588
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2020/41 Amendment 1

2 September 2020

Brooklyn Johnston
Psychology, Speech and Hearing
UNIVERSITY OF CANTERBURY

Dear Brooklyn

Thank you for your request for an amendment to your research proposal "Speech-Language Intervention for Children With Co-occurring Speech and Language Disorders" as outlined in your emails dated 10th and 26th August 2020.

I am pleased to advise that this request has been considered and approved by the Human Ethics Committee.

Yours sincerely

R. Robinson

pp.

Professor Geoffrey Rodgers
Deputy Chair, Human Ethics Committee

Appendix 5

Ngāi Tahu Consultation and Engagement Group Letter

Ngāi Tahu Consultation and Engagement Group

UNIVERSITY OF CANTERBURY

26 May 2020

Tēnā koe Brooklyn

Re: An intervention programme for three and four year old children with co-occurring speech and language disorders

This letter is on behalf of the Ngāi Tahu Consultation and Engagement Group (NTCEG). The NTCEG considered your proposal and acknowledge it is a worthwhile and interesting project and you are clear about how you ought to take participants' (cultural) needs into account if and when applicable.

Given the scope of your project, no issues have been identified and further consultation with Māori is not required.

Thank you for engaging with the Māori consultation process. This will strengthen your research proposal, support the University's Strategy for Māori Development, and increase the likelihood of success with external engagement. It will also increase the likelihood that the outcomes of your research will be of benefit to Māori communities. We wish you all the best with your current project and look forward to hearing about future research plans.

The Ngāi Tahu Consultation and Engagement Group would appreciate a summary of your findings on completion of the current project. Please feel free to contact me if you have any questions.

Ngā mihi
Maxine Bryant (on behalf of the NTCEG)

Director Research Services | Kaihautū
Research & Innovation | Te Rōpū Rangahau
University of Canterbury | Te Whare Wānanga o Waitaha
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http://www.research.canterbury.ac.nz

Appendix 6

Target Words

/sht/	*/vz/*
• *Pushed*	• Weaves
• *Washed*	• Waves
• *Wished*	• Shoves
• *Mashed*	• Lives
• *Squished*	• Moves
• *Smashed*	• Drives
• *Blushed*	• Dives
• *Brushed*	• Shaves
• *Crashed*	• Gives
• *Splashed*	

Appendix 7

Treatment Fidelity Template

Treatment Fidelity Checklist - Quality		
Date and time of session:	**Client:**	**SLT completing intervention:**
Date checklist completed:	**Person completing checklist:**	
Session Activity	**Completed: Yes / No**	**Comments**
Minimal Pairs (Williams et al., 2010)		
Included		
Therapist provided toys, materials and activities which were related to target sounds.		
Therapist familiarised the child to the target words		*Please comment on each target word. This section can be completed if this is the first time the child is exposed to the target word. This section is N/A if child has been exposed to the target words.*
Therapist instructed the child to listen and pick up target words		*Please comment on each target word. This section can be completed if this is the first time the child is exposed to the target word, or if they did not reach 80% accuracy during previous session. This section is N/A if child has reached 80% accuracy for the target word*
Therapist provided opportunities for word imitation by providing auditory models and articulation instructions ● AND/OR therapist provided opportunities for child to produce target words spontaneously		*Please comment on each target word.*
Therapist provided child with opportunities to request target words		*Please comment on each target word.*
Therapist provided opportunities for the child to produce and request target words or sounds		*Please comment on each target word.*
Following correct productions, therapist provides qualitative specific and non-specific positive feedback at an appropriate frequency ● Frequency for newly learned/low accuracy skill: every production or every second production ● Frequency for established/high accuracy skill: every five correct productions ● Specific feedback: discuss qualities of speech sound, e.g. "I heard you say both the /t/ and the /s/ that time"		*Please comment on each target word.*

• Non-specific feedback: reinforce behaviour, e.g. "you're doing some awesome work"		
Following incorrect productions, therapist provides qualitative specific feedback to identify the error the child has made, and contrasts the child's incorrect production with the correct production. E.g. child says cat but means cats, "I'm not sure what you mean. Did you mean cat (point to singular) or cats (point to double)"		*Please comment on each target word.*
Focused Language Stimulation (Lederer, 2002)		
Included		
Therapist followed the child's lead while manipulating the environment to provide opportunities for target words to be used • Therapist preselects toys, materials and activities where target words can be facilitated • Therapist follows child's interest • Therapist manipulates or interferes with play		
Therapist provided frequent and highly concentrated models of target words; 9 productions in syntactically correct sentences per minute (on average)		*Please comment on the average number of productions given.*
Therapist highlighted target words; • used prosody to emphasise target words • used high levels of repetition		
Therapist used Indirect Language Stimulation techniques (Paul et al., 2018) to model words; self-talk, parallel talk, imitations, expansions, extensions, build-ups and breakdowns, recasts		*Please comment on whether the clinician used one, a number of, or all ILS techniques.*
Therapist provided opportunities for the child to use target words		
Storybook Reading		
Included		
Therapist provided reading material which was related to target words and sounds.		
Therapist used dialogic reading strategies to facilitate dialogue • PEER strategy (Blom-Hoffman et al., 2006); prompt (using CROWD prompt format), evaluate responses,		*Please comment on whether the clinician used one, a number of, or all PEER strategies:*

expand by adding semantic information, repeat full utterance • CROWD prompts (Zevenbergen et al., 2003); completion (cloze procedures), recall (remembering and reflecting on content), open-ended questions, wh- questions, distancing (linking story content to life experiences)		*Please comment on whether the clinician used one, a number of, or all CROWD prompts:*
Therapist provided opportunities for the child to use target words		

Treatment Fidelity Checklist – Speech Quantity			
Date and time of session:	**Client:**	**Present/absent**	
SLT completing intervention:		**Length of minimal pairs (minutes):**	
Date checklist completed:		**Person completing checklist:**	
Number of trials of target skills. Write a tally mark each time the clinician uses the target word.			**Comments**
Target word 1:	Clinician opportunities (talley):		
	Correct/incorrect responses (tick/dash):		
Target word 2:	Clinician opportunities (talley):		
	Correct/incorrect responses (tick/dash):		
Target word 3:	Clinician opportunities (talley):		
	Correct/incorrect responses (tick/dash):		
Target word 4:	Clinician opportunities (talley):		
	Correct/incorrect responses (tick/dash):		

Target word 5:	Clinician opportunities (talley):		

Treatment Fidelity Checklist – Language Quantity											
Date and time of session:					**Client:**						**Present/absent:**
SLT completing intervention:						**Length of FLS (minutes):**					
Date checklist completed:						**Person completing checklist:**					
Number of trials of target skills. Each square represents one minute. The FLS portion of the session should last in total approx. 20 minutes. Write a tally mark each time the clinician uses the target word. Target – 9 per minute.											**Comments**
Target word 1:											
Target word 2:											
Target word 3:											
Target word 4:											

Target word 5:											