The efficacy of a language intervention on the acquisition of past tense in children with Down syndrome

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Signed Declaration of Originality

I, Rebecca Baxter, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I can confirm that this has been indicated in the thesis.



Rebecca Baxter 15/09/2022

Abstract

Background: Individuals with Down syndrome (DS) experience difficulties with receptive and expressive grammar and specifically morphosyntax. Despite these difficulties, there have been few studies to evaluate the effectiveness of intervention and limited evidence of generalisation to untaught items.

Aim: To evaluate the efficacy of a language intervention on the acquisition of the regular simple past tense (RSPT) in children with DS aged 7-11 years and to explore whether any gains in the use of this grammatical rule will generalise.

Method: A randomised controlled trial evaluated a 10-week intervention, using explicit and implicit methods, designed for children with DS. Fifty-two children with DS aged 7-11 years were randomly allocated into two groups: 1) intervention group and 2) delayed intervention group. All children were assessed at three timepoints: preintervention (t1), after the intervention group had received the intervention (t2), and 12-14 weeks later (after the delayed intervention group had received the intervention) (t3). The intervention was delivered by trained teaching assistants (TAs) in daily 20-minute sessions.

Results: The intervention group made significantly greater gains at t2 on a composite measure of the use of the RSPT (d=1.63). These gains were maintained 12-14 weeks later at t3 when the delayed intervention group also made similar gains. The use of the RSPT generalised to untaught regular verbs. In addition, the children made errors of overregularisation on irregular verbs demonstrating they had learnt the grammatical rule. Generalisation to other tense morphemes (e.g., the third person singular) did not occur.

Conclusions: An intervention, using explicit and implicit methods, was successful in teaching children with DS to use a grammatical rule. Furthermore, the children were able to generalise this rule to untaught items. This provides evidence for intervention targeting morphosyntax and the feasibility of training TAs to deliver this intervention.

Impact statement

This study has clear implications for clinical practice, future research and adds to the evidence base that informs theories explaining language impairment.

Children with Down syndrome (DS) are reported to experience significant difficulties with the use of grammatical morphemes, particularly those that mark tense (e.g., the regular simple past tense (RSPT) morpheme: $jump\underline{ed}$) and these difficulties continue into adolescence and adulthood. However, there have been few studies to evaluate intervention that targets any aspect of grammatical morphology with this population. These studies do report some successful gains but details and resources to replicate these findings are limited and generalisation to untaught items is uncommon.

This thesis involved the development and evaluation of an intervention that targets the use of the RSPT, taking into consideration the speech, language and cognitive difficulties associated with DS and methods that have previously been successful in interventions with children with language difficulties. This randomised controlled study with 52 children with DS was the largest study evaluating an intervention targeting grammar with this population. Following intervention, children made significant gains in their use of the RSPT and generalised the rule for marking this tense to untaught items. This skill was maintained in follow-up testing.

The intervention package used in the study could be used with other children with DS to target the same morpheme and other grammatical morphemes. It could also potentially be used with children with other kinds of language impairment. The comprehensive assessment battery, designed to evaluate gains in the use of the RSPT, could be utilised in further research and clinical practice.

The intervention was delivered by trained teaching assistants (TAs) in the children's schools and overseen by a specialist speech and language therapist (SLT). As this economical way of delivering intervention proved successful, it could be replicated in other schools in the UK, as children with DS typically do receive TA support in these settings.

Previous theories explaining the problems that children with DS (and Developmental Language Disorder) have in learning grammatical structures refer to difficulties with the implicit learning of grammatical rules. In this study the rule for applying the RSPT was taught explicitly but the children then applied the rule implicitly to untaught verbs and even generalised the rule to irregular verbs (e.g., goed). Therefore, this finding provides some alternative hypotheses on the causes of these kind of language difficulties.

The key findings from this study have already been disseminated nationally and internationally via professional and public platforms during the completion of this PhD. The audiences have included researchers, SLTs and parents and through this dissemination, this information has the potential to benefit future research and clinical practice.

Publication

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Presentations

2022

Down Syndrome Clinical Excellence Network Study Day: Online presentation "Techniques from a successful intervention targeting grammar"

2022

UCL Centre for Speech and Language Intervention Research: Speech, language, communication, and swallowing in children- clinical implications from recent research: Online presentation "Evaluating a language intervention for children with Down syndrome"

2019

International Association for the Scientific Study of Intellectual and Developmental Disabilities (IASSIDD 2019) World Congress: Oral presentation "Understanding and applying a grammatical rule: a randomised control trial"

52nd Annual Gatlinburg Conference: Research and theory in intellectual and developmental disabilities: translational research on Down syndrome: Oral presentation "An evaluation of a language intervention for children with Down syndrome"

2018

Word Down Syndrome Congress: Poster presentation "Evaluating a language intervention for children with Down syndrome"

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Abbreviations

The following table describes the common abbreviations and acronyms used throughout this thesis. The page on which each one if defined or first used is also given. Nonstandard acronyms that are used in some places throughout this thesis (e.g., names of assessments) are not included in this list.

Abbreviation	Meaning	Page
DLD	Developmental language disorder	19
DS	Down syndrome	18
MLU	Mean length of utterance	31
RSPT	Regular simple past tense	18
SLT	Speech and language therapist	20
TA	Teaching assistant	101

1. Introduction to this PhD

The main aim of this study was to evaluate the effectiveness of an intervention to improve the use of the regular simple past tense (RSPT) by children with Down syndrome (DS). Individuals with DS are reported to experience significant difficulties with morphosyntax (e.g., Bol & Kuiken, 1990; Chapman et al., 1998; Eadie et al., 2002; Laws & Bishop, 2003). Whilst few studies have explored the specific difficulties with morphosyntax, there is some agreement that tense morphology is particularly impaired (e.g., Chapman et al., 1998; Laws & Bishop, 2003; Ring & Clahsen, 2005). Despite this knowledge there have been very few intervention studies targeting the use of morphosyntax by individuals with DS. Two known studies are those by Sepúlveda et al. (2013) and Buckley (1993). These studies include relatively small sample sizes and target syntax and morphosyntax more generally. It is unclear whether any gains reported in these studies are restricted to those specifically taught or whether there has been any generalisation to untaught forms. Given the limited number of interventions and the agreement around difficulties with tense morphology, tense was chosen as the target for the intervention. The current study aimed to investigate whether children with DS could be taught to use a grammatical rule (the rule that governs RSPT marking in English) and whether any gains would generalise to untaught items.

In order to achieve this aim, an intervention that was suitable for children with DS was required. Given the limited studies specifically focussing on DS and the limited detail provided regarding these studies, no current intervention was considered appropriate. Therefore, a new intervention targeting the regular simple past tense (Past Tense Intervention 'PaTI') was developed specifically for this population. There is a specific health, cognitive, speech and language profile associated with DS. In order to develop an intervention suitable for children with DS these associated strengths and difficulties needed to be understood. Therefore, Chapter 2 outlines these areas in preparation for developing an intervention that takes into account the relative strengths and difficulties associated with DS.

The next stage of this study was to explore the literature on the development of Morphosyntax and its measurement in typically developing children. Chapter 3 includes the factors that influence the acquisition of morphemes for all children as

these would potentially also impact children with DS. In addition, the methods for assessing morphosyntax were reviewed in order to establish the implications for developing an assessment battery that could potentially measure gains following the intervention.

Chapter 4 further explores the development of tense specifically, focussing on the linguistic and phonological factors as well as the processing limitations associated with the development of the regular simple past tense. Difficulties developing morphosyntax are discussed regarding children with Developmental language disorder (DLD) who are reported to experience specific difficulties with tense (e.g., Norbury et al., 2001; Rice et al., 1995; Rice & Wexler, 1996). In addition, children with DLD have been compared to individuals with DS in terms of these difficulties with morphosyntax (e.g., Eadie et al., 2002; Laws & Bishop, 2003; 2004a). Finally, accounts for the causes of these difficulties are discussed culminating in an overview of the Procedural Deficit Hypothesis (Ullman, 2004; Ullman & Pierpont, 2005) which suggests that deficits in the procedural memory system are responsible for difficulties with the implicit learning of morphosyntax for children with DLD.

Chapter 5 draws together the information from the previous chapters to provide an overview of the specific difficulties with morphosyntax reported for individuals with DS. The factors that impact the development of morphosyntax for all children are discussed, together with how the specific profile associated with DS may further impact this development. A comparison is also drawn between the cognitive and language profile of children with DS and DLD, together with the difficulties with morphosyntax experienced by both groups. This culminates in the rationale and the research questions for the current study. The research questions are:

- 1. How effective is an intervention that teaches the use of the RSPT forms, using implicit and explicit techniques, for children with DS?
- 2. If such an intervention can be shown to be successful, will learning generalise, and, in particular, will children demonstrate errors of overregularisation after the intervention?

The development of an intervention to teach the use of the RSPT (Past Tense Intervention 'PaTI') is described in Chapter 6, which considered the strengths and difficulties associated with DS and methods used in previous intervention studies for individuals with DS and other children with language impairments. The subsequent implicit and explicit therapy techniques used in the PaTI intervention are also detailed in Chapter 6 with some examples of the resources used.

Chapter 7 provides the methodology for the current study and includes participant details including information regarding the speech and language therapist (SLT) input they were receiving. The selection of the assessments used in the study are explained, together with the explanation of the bespoke measures developed. These bespoke measures considered the information discussed in Chapter 4 and Chapter 5, which takes into account the assessment of morphosyntax for all children and the factors associated with developing the RSPT in a range of contexts. In addition, their use with children with DS was also carefully considered.

Finally, the results of the intervention are presented in Chapter 8 and these results are discussed in Chapter 9 in relation to the research questions. In addition to answering the two research questions, this study collected one of the largest samples of data on the use of the regular simple past tense in children with DS. Due to the previous limited, small-scale studies, the difficulties with morphosyntax at t1 are explored and compared with previous research. Chapter 9 summarises what has been learnt during this study, how this aligns with previous theories referring to difficulties with the implicit learning of grammatical rules and implications for future research.

2. Introduction to Down syndrome

DS is the most common genetic neurodevelopmental disorder affecting approximately one in 800 live births (de Graaf et al., 2015). Trisomy 21 is the most common cause of DS, accounting for 98% of cases (see Roberts et al., 2007), resulting in an additional copy of chromosome 21. Translocation, where part of chromosome 21 attaches to another chromosome, and Mosaicism, where some but not all cells have an additional copy of chromosome 21, are much rarer forms of DS.

In the following sections, the most common issues associated with DS relevant to this study are reviewed.

2.1. Health

2.1.1. Hearing

Hearing difficulties are highly associated with DS. Babies with DS often experience otitis media with effusion (OME or glue ear) from birth (35%) (Tedeschi et al., 2014) and this rises to a prevalence of 93% at one year of age (Barr et al., 2011). By five years, incidence of OME has dropped to 68% and subsequently 38% by aged 8 years (Barr et al., 2011). Despite this knowledge, children with DS are often underdiagnosed and undertreated for chronic ear infection (Roizen et al., 1994), a finding echoed in other studies (e.g., Austeng et al., 2013). There is also a higher incidence of sensorineural hearing loss identified in new-borns with DS (Park et al., 2012) with up to 18% of 8-year-olds are diagnosed with a sensorineural hearing loss (Austeng et al., 2013). Furthermore, age-related sensorineural hearing loss is more common and develops significantly earlier in adults with DS (Meuwese-Jongejeugd et al., 2006). Up to 60% of adolescents and young adults with DS continue to present with a mildmoderate hearing (conductive or sensorineural) loss in one or both ears (Chapman et al., 2000). It is therefore recommended that children with DS have their hearing tested every six months up to two years of age, and then at least annually throughout school years and once every two years throughout adult life (Down Syndrome Medical Interest Group (DSMIG), 2017).

This early period of development is obviously a critical time for learning language. Early hearing loss in children with DS has been found to significantly impact on later speech and language performance (Laws & Hall, 2014).

2.1.2. Vision

Young children with DS also experience significantly more vision related difficulties including refractive errors (including long/farsightedness, short/nearsightedness and astigmatism) and/or squint, nystagmus, congenital cataract and infantile glaucoma) (DSMIG, 2012). It is recommended that children with DS have a formal ocular/visual assessment between 18 months and two years as at least one third will experience visual difficulties by this age (Woodhouse et al., 1997). By four years, at least 50% will have refractive errors (Woodhouse et al., 1997). In addition to refractive errors, 92% of young children (between four weeks and 48 months) have difficulties with accommodation (maintaining focus as the distance of an object varies). Furthermore, difficulties with visual acuity appear more frequently from two years with as many as 80% of children having difficulties with acuity at age 9;8 years (Postolache, 2019). Difficulties with accommodation and acuity persist even when refractory issues are corrected with glasses (Down's Syndrome Vision Research Unit, n.d.). Therefore, from two years, children with DS are recommended to have their vision checked biennially (DSMIG, 2012) although others (Down's Syndrome Vision Research Unit) recommend annually.

2.1.3. Sleep

Children with DS are reported to be more prone to sleep problems than typically developing children and children with other genetic syndromes such as Williams syndrome (Ashworth et al., 2013). Sleep problems include disruption, frequent night waking, restlessness, bedtime resistance as well as sleep disordered breathing and sleep apnoea. Sleep apnoea is an occlusion of the upper airway which can result in intermittent hypoxia and disturbed sleep and has been reported in 80% of children with DS (Austeng et al., 2014; Barr et al., 2011). Furthermore, studies have reported school aged children with DS with sleep apnoea had poorer verbal IQ and cognitive flexibility compared to those without sleep apnoea (Breslin et al., 2014). A similar pattern has been identified in younger children with DS showing sleep apnoea was associated

with poorer working memory (Joyce et al., 2020) and correlates with the number of words produced by 12-18 months (see Abbeduto et al., 2020).

2.1.4. Other associated health issues

DS is associated with a number of additional health issues. Between 40 and 60% of babies have a congenital heart defect (Frid et al., 1999) and early surveillance and treatment is recommended to limit irreversible pulmonary vascular disease. Congenital gastrointestinal defects are also more common, found in 6.1% of babies with DS (Frid et al., 1999). People with DS are more prone to respiratory tract infections and have been found to have poorer immune systems due to lower levels of lymphocytes and antibodies as well as reduced antibody response to immunisation (Ram & Chinen, 2011). Thyroid disorders are more common in individuals with DS (Amr, 2018), before becoming more prevalent in teenage years (Nobel et al., 2020). Health issues have been reported to be associated with the severity of intellectual disability in individuals with DS (Määttä et al., 2006).

Individuals with DS have differences in oral-motor structure and function (Dodd & Thompson, 2001; Smith & Stoel-Gammon, 1983; Stoel-Gammon, 1997), including a vaulted (high, narrow and arched) palate, a relatively small oral cavity compared to tongue size and enlarged tonsils and adenoids. Individuals with DS also experience differences with dentition (alignment, gaps, occlusion) (Barnes et al., 2006). These differences have been reported to be at least partly responsible for difficulties with articulation, with even lower scores on speech function tasks compared to oral function skills (Barnes et al., 2006).

The brain structures of individuals with DS are noted to be underdeveloped in the frontal and temporal areas which hosts crucial areas for language (e.g., Broca and Wernicke areas) (Rondal, 2017).

2.2. General cognitive development

DS is associated with cognitive impairments although the degree of cognitive impairment ranges considerably (Roberts et al., 2007). The IQs of children with DS have been found to vary from between 30 to 70 (Chapman et al., 2002). Whilst this

range can vary from close to typical cognition to severe cognitive impairment, the majority of children, (approximately 80%) experience moderate cognitive impairments (see Roberts et al., 2007).

Evidence of early differences in social cognition, including early visual and verbal attention difficulties, is reported. Young children with DS are later to establish mutual gaze although they are then reported to maintain this whist typically developing children start to focus on the wider environment (e.g., Berger & Cunningham 1981; Carvajal & Iglesias, 2000). Subsequently, children with DS are delayed in acquiring joint attention (e.g., Legerstee & Weintraub,1997). Some researchers have suggested that this heightened mutual gaze from very young, is an early indicator of the sociable strengths associated with DS (e.g., Ruskin et al., 1994). However, others have argued this is due to poor attention shifting between people and the environment (e.g., Cebula et al., 2010). Task persistence is reported to be lower than typically developing mental age matched peers and parents report children with DS are more distractable (e.g., Gunn et al., 1981; Gunn & Cuskelly, 1991). Imitation is reported as a relative strength and has also been linked to the idea of individuals with DS being more socially motivated (e.g., Hodapp et al., 1992; Pueschel et al., 1987).

The gap in cognitive skills between preschool children with DS and typically developing peers is reported to increase over time (Chapman & Hesketh, 2001). Some areas of cognition are more impaired than others, and verbal short-term memory seems to be particularly impaired (e.g., Jarrold et al., 2002). These early difficulties are suggested to impact later social cognitive abilities including emotion recognition, theory of mind and empathy (see Cebula et al., 2010).

Emotion recognition is suggested to be delayed, with individuals with DS demonstrating difficulty interpreting facial expressions (e.g., Kasariet al., 2001; Wishart & Pitcairn, 2000) which continues into adulthood (e.g., Hippolyte et al., 2008). However, response to distress in others has been found to be a relative strength compared to typically developing children matched on nonverbal mental age and those with nonspecific intellectual difficulties (Kasari et al., 2003).

Theory of mind (i.e., the ability to comprehend another person's knowledge and state of mind) is reported to be delayed compared to mental age match controls (e.g.,

Abbeduto et al., 2001; Neitzel & Penke 2021; Zelazo et al., 1996), despite early reports of relatively good performance on false belief tasks used to assess theory of mind abilities (e.g., Baron-Cohen et al., 1985; Yirmiya et al., 1996). More recently, research has shown these social cognitive factors are significantly associated with other cognitive factors such as verbal short-term memory (Neitzel & Penke 2021) and verbal mental age (Baron-Cohen et al., 1985; Zelazo et al., 1996).

2.2.1. Memory

Working memory is considered a multicomponent system (e.g., Baddeley, 1981; Baddeley & Hitch, 1974) and some components, such as verbal short-term memory, are specifically impaired in individuals with DS (e.g., Jarrold et al., 2006). The verbal short-term memory system receives verbal information from the world around and is often referred to as phonological short-term memory when referring specifically to speech related information (sounds, words and sentences).

Verbal short-term memory is delayed compared to non-verbal mental age (e.g., Jarrold et al., 2006; Kay-Raining Bird & Chapman 1994; Seung & Chapman 2000) and its development in individuals with DS is extremely slow (Chapman et al., 2002; Hick et al., 2005). Performance on verbal short-term memory tasks such as digit span and nonword repetition is poor in comparison to visuo-spatial short-term memory tasks or measures of nonverbal mental age more generally (e.g., Jarrold et al 2002; Miolo et al 2005, Seung & Chapman 2000). Whilst digit spans are commonly around 7 for the typical population (e.g., Baddeley, 1994; Miller, 1956), forward digit spans for individuals with DS are considerably lower, commonly around 4 (Kay-Raining Bird & Chapman, 1994). Few studies have looked at the development of verbal short-term memory in young children with DS due to the task demands (Conners et al., 2018) as 6-year-olds have been found to score at floor on these tasks (e.g., nonword repetition and word span tasks) (Nass et al., 2015). This phonological verbal short-term memory (which is responsible for holding sequences of speech sounds) depends on the phonological loop which is assumed to hold speech related information for approximately 1.5-2 seconds in a subcomponent known as the phonological input store (Baddeley, 1994). This information is lost after this short time unless it is refreshed by the second component of the phonological loop, the articulatory rehearsal process. Evidence suggests individuals with DS have a deficit in the phonological input store whilst the articulatory rehearsal process needs further investigation (Seung & Chapman, 2000). A link between phonological short-term memory and language development has been suggested (e.g., Gathercole & Baddeley, 1989) with reduced short-term memory capacity believed to constrain new word learning (e.g., Baddeley et al., 1998). In addition to the difficulties with phonological short-term memory, the processing of auditory information in general is reported to be impaired in individuals with DS compared to mental age and chronologically age matched controls (Lincoln et al., 1985). Furthermore, individuals with DS perform worse on sentence repetition over two words, than controls with intellectual abilities matched on mental age (Marcell et al., 1995) potentially demonstrating the specific difficulties with phonological short-term memory experienced by individuals with DS compared to those with similar levels of intellectual impairment (non-DS).

Verbal short-term memory performance has been found to predict vocabulary level five years later (Laws & Gunn, 2004). In the initial study, the participants were between five to 19 years (mean age 11;2 years) and the authors followed-up these participants five years later (mean age 16;5 years). Given the evidence supporting the crucial role phonological short-term memory plays in learning new words, it is perhaps surprising that individuals with DS have a relative strength in receptive vocabulary (discussed later in this chapter (2.3.3)). There is some evidence that individuals with DS have difficulty with fast mapping (pairing novel words with novel objects) (e.g., Chapman et al., 1990) although evidence is mixed (e.g., Kay-Raining Bird et al, 2000b). A possible explanation comes from evidence that referent learning is relatively unimpaired, instead it is the detailed phonological form learning that is impaired (see Jarrold et al., 2009). In receptive vocabulary tasks, individuals are typically asked to select the correct picture when the assessor provides the word. It is argued that performance on this type of task fails to take account of an individual's stored inaccurate phonological representations (the options rarely include two phonological forms that are very similar). Jarrold et al. (2009) carried out a study to investigate this referent vs phonological form learning. They found that the individuals with DS in their study (aged 14;5-29;0 years) were able to select the correct novel item when the word was presented consistently (point to correct item from a choice). However, when asked to select the correct name from a choice of three very similar phonological forms, the individuals were significantly impaired. The authors concluded that when individuals

with DS learn new words, the stored phonological forms in the lexicon are often inaccurate due to the impaired phonological short-term memory failing to hold this detailed information during learning.

In addition to the difficulties associated with verbal short-term memory, individuals with DS are reported to experience difficulties with long-term memory. Long term memory is associated with explicit (also referred to as declarative memory) and implicit (or procedural memory) (e.g., Squire, 1987; Vicari et al., 2000a). Explicit memory is associated with conscious learning and recall, in contrast implicit memory is associated with unconscious learning over time. Individuals with DS have been shown to perform worse on explicit learning tasks compared to typically developing controls matched on nonverbal mental age (e.g., Carlesimo et al., 1997; Vicari et al., 2000a). Vicari and colleagues (2000a) compared the performance of 14 adults with DS (aged 21 years) on a series of implicit and explicit memory tasks requiring visual and verbal perceptual processing, to typically developing controls matched on nonverbal mental age. The group with DS performed significantly worse than controls on the explicit tasks. The authors concluded that a dissociation between the two memory systems is observed in DS. The evidence regarding implicit memory in DS is mixed, with some researchers reporting it be a relatively spared (e.g., Vicari et al., 2000b; Vicari et al., 2007) and others reporting this is not as clear cut (e.g., Bussy et al, 2011). Bussy and colleagues (2011) reported that although reaction times in individuals with DS was comparable to a typically developing group matched on nonverbal mental age initially, the performance of the group with DS did not continue to improve over the final block of trials. The authors concluded that although implicit learning appeared on the surface to be similar to the typically developing group, it appeared that procedural memory may not be sufficiently resilient. Studies comparing implicit and explicit memory in DS have concluded implicit memory is independent from cognition (e.g., Bussy et al., 2011; Vicari et al., 2007). These inconsistent findings regarding implicit and explicit memory are observed across a range of populations and studies have been criticised for the use of measures with low reliability as a reason behind these inconsistencies (e.g., West et al., 2017).

Explicit memory is associated with the prefrontal cortex, caudate nucleus and a number of medial-temporal lobe structures. Implicit memory is associated with the

frontal, parietal and superior temporal cortices of the left bran, the left basal ganglia and the right-neocerebellar. These structures are associated with those reported to be underdeveloped in individuals with DS and implicit memory has been suggested as playing a direct role in the language difficulties associated with DS (Rondal, 2017).

2.3. General speech and language development

2.3.1. Pragmatics

Children with DS are delayed in terms of a wide range of pragmatic skills compared to chronological age matched controls (e.g., Abbeduto, 2008; Berglund et al., 2001; Smith et al., 2017). Therefore, nonverbal mental age matched comparisons are frequently used, allowing a more informative comparison (e.g., Smith et al., 2017). Research has shown that individuals with DS show relative strengths with some aspects of social interaction from an early age compared to mental age matched controls e.g., sharing and cooperation (Sigman & Ruskin, 1999) and non-verbal communication (Fidler, 2005; Franco & Wishart, 1995; Smith et al., 2017), although non-verbal requesting is reported to be more impaired (Abbeduto, 2008; Fidler et al., 2005). The use of gestures has been reported as a particular strength compared to nonverbal mental age matched controls (Franco & Wishart, 1995). It has been argued that assessments that use parental report (e.g., Children's Communication Checklist (CCC-2), Bishop, 2003b) are a better measure of pragmatic skills as they reflect the child in a range of natural settings (Bishop, 1998). Despite some of the reported strengths in early pragmatic skills, children with DS as young as 6 years are already reported by their parents to have difficulties on a range of pragmatic skills (e.g., initiation, scripted language, context on the CCC-2) falling at least one standard deviation below the norm for typically developing children matched on chronological age or mental age (Smith et al., 2017). It is important to note that these subscales are reflecting language and many children with DS will have limited expressive language at this age as discussed below. The authors reported that although pragmatic scores were delayed, they were significantly higher than the scores on the linguistic subscales (i.e., speech, syntax, semantics and coherence). One study using the same parental report assessment, stated that they only included participants with DS who produced complete sentences in a narrative task due to the language level assumed by the

CCC-2 (Laws & Bishop, 2004b). The age of this group was 10;2-22;9 years, suggesting that the assessment may not have been suitable for the younger group.

In terms of verbal language, initiation of conversation has been reported to be a strength compared to younger mental age matched typically developing children (Laws & Bishop, 2004b) although research is mixed (e.g., Roberts et al., 2007; Martin et al., 2009). Later, more complex pragmatic skills that rely on language such as providing context (Laws & Bishop, 2004b; Smith et al., 2017) or elaboration (Coggins & Stoel-Gammon, 1982) are more delayed although topic maintenance and providing clarification when prompted has been reported to be comparable to nonverbal mental age matched typically developing controls (Coggins & Stoel-Gammon, 1982; Tannock, 1988). Adolescents and school age children with DS are less likely to signal comprehension problems in tasks when inadequate information is provided (Abbeduto et al., 2008).

Given these pragmatic difficulties, the cognitive difficulties and the difficulties with syntax (discussed later in this chapter (2.3.2)), it is perhaps unsurprising that there have been limited studies focussing on non-literal language in individuals with DS. A single case study (Papagno & Vallar, 2001) and an experimental study (Shnitzer-Meirovich et al., 2017) have investigated metaphor understanding and similarly the understanding of idioms has received little attention (Papagno & Vallar, 2001; Roch & Levorato, 2010). Verbal and visual metaphor comprehension is reported to be significantly impaired (Papagno & Vallar, 2001; Shnitzer-Meirovich et al., 2017). The limited research on idioms is mixed with results from tasks requiring verbal explanation impaired (Papagno & Vallar, 2001) but multiple-choice responses, following a story providing some contexts, were similar to typically developing controls matched on reading comprehension (Roch & Levorato, 2010). It is therefore difficult to tease apart these interlinked aspects of development and to establish whether difficulties in pragmatics are a reflection of general cognitive difficulties and/or language difficulties or are a specific pragmatic deficit.

2.3.2. Syntax

The emergence of syntax is related to vocabulary size in typically developing children, with children starting to combine words once their expressive vocabulary reaches 50-

100 words, and then combining three words with the emergence of some early grammatical morphemes at approximately 250-300 words (e.g., Bates & Goodman, 1997). This requires a range of vocabulary including verbs which are reported to be a particular challenge for individuals with DS discussed later in the chapter (2.3.3.1). The emergence of syntax has also been associated with a similar pattern of vocabulary size for children with DS albeit at a much later age: for typically developing children this occurs between 12 and 30 months, and for children with DS, between 3 and 8 years (Buckley, 2000). Whilst the children with DS are older, the emergence of early word combinations in children with DS are observed at a similar mental age as for typically developing children (Miller et al., 1995) chronological age 36-55 months (Levy & Eilam, 2013; Oliver & Buckley, 1994). Despite children with DS continuing to expand their vocabularies, there is reported to be a dissociation between grammar and the lexicon unlike that seen in typical development or in other genetic conditions such as Williams syndrome (Bates et al., 2017). This progression from one to twoword utterances has been identified as a particular delay (Iverson et al., 2003) and sentence length and complexity are slower to develop from this point (Chapman, 1997).

From this early challenge in putting words together, syntax continues to be a specific area of difficulty for individuals with DS and is generally considered more impaired than receptive and expressive vocabulary (e.g., Laws & Bishop, 2003; Næss, et al., 2011; Vicari et al., 2000b). Adolescents with DS produce shorter, simpler sentences than mental age matched controls (Caselli et al., 2008; Chapman et al., 1998; Price et al., 2008) with less complex noun phrases, verb phrases and sentence structures (Price et al., 2008). Function words are often omitted and language samples from individuals with DS have been referred to as telegraphic (e.g., Vicari et al., 2000b). Inflectional morphemes encoding grammatical contrasts such as tense agreement are particularly problematic and this is discussed further in Chapter 5.

Whilst it is agreed that grammar is a particular challenge, there is less agreement over whether this difficulty is experienced equally across receptive and expressive domains. Whilst several narrative reviews have suggested that expressive language is behind receptive language (e.g., Chapman, 1997; Laws & Bishop, 2004a) other

authors have criticised these reviews for being unsystematic and lacking clear criteria for the inclusion of studies (e.g., Næss, et al., 2011).

Difficulties with syntactic comprehension in comparison to mental age matched younger controls have been reported across a range of constructions including the interpretation of passives (e.g., the fish is eaten by the man) (e.g., Joffe & Varlokosta, 2007; Ring & Clahsen, 2005) reflexive pronouns (e.g., Mowgli is tickling himself) (e.g., Fortunato-Tavares et al., 2015; Perovic, 2006; Ring & Clahsen, 2005) and for questions containing who-subject, what-object, which-NP subject and which-NP object question types (Joffe & Varlokosta, 2007). The authors also included a repetition and elicitation assessment on the question constructions and found the group with DS performed significantly worse on both. Performance of a small group of adults with DS (aged 24-47 years) displayed syntactic comprehension difficulties (not scoring above chance) for comprehension of simple subject-verb-object sentences (Perovic & Wexler, 2019). Further difficulties have also been reported on a range of complex sentences (e.g., those that include relative clauses, complement clauses and adverbial clauses) (Frizelle et al., 2018). The authors report that the group of children with DS (age 6;10-11;08 years) scored at floor on all but one (intransitive subject relative clauses) of the 13 complex sentences assessed (including relative clauses, adverbial clauses and complement clauses). This was significantly lower than a typically developing group matched on nonverbal mental age but more importantly they also scored significantly lower than a third group of individuals with cognitive impairments of unknown etiology, again highlighting the particular syntactic difficulties associated with DS.

A study looking at complex sentence production compared individuals with DS spanning 12;5-20;4 years, to preschool controls matched on mean length of utterance (MLU) (Thordardottir et al., 2002). The group with DS produced significantly more utterances than the younger group and therefore a proportionate sample was analysed. Despite the large number of utterances, less than 10% contained complex sentences. Those that did, demonstrated a range of complex constructions, some of the most common included; conjoined sentences, simple infinitive clauses with equivalent subjects, full propositional complements, simple non-infinitive *wh*-clauses, sentences with relative clauses (Thordardottir et al., 2002). However, conflicting

evidence reported that individuals with DS performed almost at floor on comprehension of complex sentences (e.g., Frizelle et al., 2018). One possible explanation put forward by Frizelle et al. (2018) was the age of participants. The participants with DS in Frizelle et al. (2018) were 6;10-8;11 years (mean mental age 6;7 years) whilst the participants in Thordardottir et al. (2002) were older 12;5-20;4 years (no mean mental age provided). Longitudinal studies provide mixed findings to suggest whether expressive grammar gains in the older participants could account for these differences; with some studies suggesting gains (e.g., Chapman et al., 2002; Martin et al., 2013) whilst others finding little improvement (e.g., Conners et al., 2018; Kay-Raining Bird et al., 2000a). Longitudinal studies also show some gains in receptive grammar (e.g., Chapman et al., 2002; Laws & Gunn, 2004) although gains in adolescents are mixed (Conners et at, 2018; Laws & Gunn, 2004) with some suggestions of decline in receptive grammar from around 17 years (Chapman et al., 2002; Laws & Gunn, 2004). The effects of dementia on the language performance of adults with DS (mean age 38 years), even on simple (e.g., subject-verb-object) sentences, has been discussed (e.g., Perovic & Wexler, 2019).

Individuals with DS experience specific difficulty with morphosyntax, both with free morphemes (e.g., auxiliary verbs, copular verbs, prepositions, articles) and bound morphemes (e.g., RSPT -ed, third person singular -s). The focus of the intervention in this study targeted the use of the RSPT. Therefore, the specific difficulties with morphosyntax are discussed in Chapter 5, together with the potential factors associated with DS that potentially contribute to these difficulties.

2.3.3. Vocabulary

Before the emergence of syntax, children with DS show earlier delays in vocabulary acquisition (e.g., Berglund et al., 2001; Miller et al., 1995; Stoel-Gammon, 2001). Typically developing children start to produce their first spoken words at approximately 12-13 months, in line with their mental age. The mean age of first words for children with DS is approximately 21 months (Stoel-Gammon, 2001) and reported to be in line with mental age (Miller, 1998), although the age of first words for children with DS is widely variable. Berglund et al. (2001) found 12% of their group of one-year-olds with DS had produced their first word and this percentage had risen to 80% of their two-year-old group. However, these authors highlight the individual differences in this

population with the range of expressive vocabularies for their group of 5-year-olds from 0 to 655 words. This range in vocabulary, highlighting the degree of individual differences from early in individuals with DS, is common (e.g., Miller et al., 1995; Zampini & D'Odorico, 2013).

Parental report of vocabulary has shown that the delays in early word production increase with age, with children with DS falling further behind over time (Miller et al., 1995; Zampini & D'Odorico, 2013). Whilst early vocabulary at 20 months mental age has been found to predict vocabulary at 28 months (Miller et al., 1995) the rate of vocabulary growth is highly variable (Kaat-van den Os et al., 2017). Whilst some children with DS show a similar acceleration of vocabulary acquisition as typically developing children (Berglund et al., 2001; Galeote et al., 2007; Miller, 1998; Oliver & Buckley, 1994) other children with DS show a much more gradual or even limited progression between 18 and 30months (Kaat-van den Os et al., 2017).

Whist this vocabulary delay is well documented, there have been few studies analysing the types of words in these early vocabularies. Gillham (1990) compared the first 50 words of four children with DS to those of typically developing children. Whilst very similar patterns were observed across typically developing groups of children, the group with DS showed significantly less use of *action words* (defined as "words that describe, demand, or accompany action or that express attention or demand for attention", Gillham, 1990 p26).

A dissociation between expressive and receptive vocabulary is observed in children with DS as young as 10-49 months (Cardoso-Martins et al., 1985; Caselli et al., 1998). Receptive vocabulary becomes a relative strength for individuals with DS as age increases relative to expressive vocabulary, receptive and expressive syntax (e.g., Abbeduto et al., 2007; Chapman et al., 1991; Conners et al., 2018; Cuskelly et al. 2016; Næss et al., 2011). In fact, some studies have reported higher receptive vocabulary scores for individuals with DS than their nonverbal mental age scores (Abbeduto et al., 2007; Næss et al., 2011) and higher than mental age matched controls (Chapman et al., 1991; Mason-Apps et al., 2020).

Whilst expressive vocabulary development progresses at a slower rate, gains are reported across studies from young school age children with DS (Hick et al., 2005) to

those focussing on early adolescence (Conners et al., 2018). In fact, although expressive vocabulary is more delayed than receptive vocabulary, it remains higher than receptive and expressive syntax (Næss et al., 2011). However, it has been reported that vocabulary development may slow down and even decline in adulthood (Conners et al., 2018).

2.3.3.1. Verbs

The research on early vocabulary acquisition data, suggests vocabulary related to actions is particularly problematic for children with DS (Gillham, 1990). Evidence suggests that this difficulty with verbs continues to be reflected in later language use. Whilst children and adolescents with DS have been found to produce a greater diversity of lexical verbs compared to controls matched on MLU, they produce a smaller number of mental state verbs (Grela, 2002; Hesketh & Chapman, 1998). The greater number of lexical verbs could potentially be accounted for by the older age of the individuals with DS (6-16 years across the two studies) compared to the MLU matched controls (2:5-5 years). By matching on MLU, the individuals with DS were considerably older and would be expected to have larger vocabularies following longer exposure to language. However, this rationale would not explain the limited number of mental state verbs, which suggests that these pose a particular challenge. More importantly, despite access to a wider range of lexical verbs, individuals with DS use verbs (both lexical and mental state verbs) significantly less than those matched on MLU (Grela, 2002; Hesketh & Chapman, 1998) and nonverbal mental age (Loveall et al., 2019).

An experimental narrative retell task identified that individuals with DS (aged 11;11-32;10 years) omitted significantly more verbs that required two or three arguments compared to controls matched on receptive vocabulary (Michael et al., 2012). The group with DS also performed poorly on a grammatical judgement task involving verbs, but performed equally well on tasks of verb comprehension and single verb naming. The authors fail to report whether the verbs in the receptive and expressive vocabulary assessments are the same as those included in the narrative retell. Therefore, it is unknown whether the verbs were mastered in vocabulary tasks and omitted specifically in contexts that require more complex argument structures. It is possible

that these verbs are not mastered, potentially due to the complex arguments they require.

The difficulties with verbs observed in individuals with DS could potentially exceed that of other intellectual disabilities (causes generally unknown but with a school or clinical classification) although research comparing these groups is limited (e.g., Loveall et al., 2019). This finding needs to be interpreted with caution as the group with intellectual disabilities (non-DS) were matched on chronological age although analysis accounted for any potential impact of nonverbal cognition on group differences. In this study, whilst the group with DS (mean age 15;83 years) scored similarly to the group with intellectual disability (mean age 16;07 years) on measures of verb density (proportion of utterances that contain a verb) and diversity (number of different verbs), the group with DS scored significantly lower on verb type-token ratio (number of different verbs relative to total number of different words). The authors concluded that the individuals with DS used a lower percentage of words that were verbs in narratives than those matched on nonverbal mental age and those with other intellectual disabilities.

The evidence that the use of verbs is potentially a particular difficulty for individuals with DS could be an important factor in the development of syntax, or rather the difficulties in syntax for this population.

2.3.4. Speech

Given the differences in oral motor structure and function and the impaired hearing, phonological short-term memory and auditory processing difficulties experienced by individuals with DS discussed earlier in this chapter, it is unsurprising that difficulties with speech ensue. Individuals with DS experience difficulties with speech that impact intelligibility to unfamiliar and familiar conversation partners (Kumin, 1994).

Difficulties with speech development may emerge early with a delay in canonical babbling and a less consistent pattern in babbling compared to typically developing children (e.g., Lynch et al., 1995; Smith & Oller, 1981) although research findings are mixed (Dodd, 1972; Steffens et al., 1992). Babble has been found similar in terms of consonants and vowels however, children with DS tend to be at a stage of babble for much longer than typically developing controls. Babbling has been suggested to form

the foundation for later speech development, with typically developing children who produce more canonical babble scoring higher on later speech and language measures (see Stoel-Gammon, 1997). Despite the similarities in babble patterns, production of first words is significantly delayed although hugely variable (e.g., Berglund et al., 2001; Lynch et al., 1995; Miller et al., 1995; Smith & Oller, 1981; Stoel-Gammon, 2001).

As children with DS start to produce words, articulation and phonological difficulties emerge. There is limited and mixed research on the speech development of children with DS. Some studies report children with DS experiencing similar phonological error patterns seen in typical speech development, including cluster reduction, final consonant deletion, stopping, prevocalic voicing and gliding (Dodd, 1976, Stoel-Gammon, 1980). However, children with DS experience a higher number of these phonological errors and errors are inconsistent (e.g., Dodd, 1976; Stoel-Gammon, 1997). In addition, a number of atypical phonological errors are also experienced including initial consonant deletion, backing and palatalisation. Phonemes are reported to emerge in a similar pattern to that seen in typical development with nasals, stops and glides emerging earlier (Kumin et al., 1994) whilst fricatives, affricates and liquid errors are common (Stoel-Gammon 1997). These errors are present in speech samples from children (e.g., Burgoyne et al., 2021), adolescents (e.g., Van Borsal, 1988; 1996) and adults (e.g., Van Borsal, 1996) demonstrating the persistent nature of these speech difficulties.

2.3.5. Phonological awareness

Phonological awareness refers to an awareness of the internal sound structure of a word and the ability to manipulate sounds in words (e.g., Næss, 2016). There is disagreement whether phonological awareness is dependent on a single ability, which develops from simple tasks to more complex skills over time (e.g., Anthony et al., 2002) or whether there are separate phonological skills (e.g., Hatcher & Hulme, 1999). There is much debate upon the various skills associated with phonological awareness (see Hatcher & Hulme, 1999). However, it is generally agreed that skills relate to either the smaller phoneme unit or the larger rime unit. Further it has been argued that phoneme manipulation skills (e.g., phoneme deletion, detection, segmentation) predict

responsiveness to reading intervention unlike rhyme manipulation skills (e.g., rhyme and alliteration) (e.g., Hatcher & Hulme, 1999).

Individuals with DS have a particular difficulty with rhyme compared to typically developing children matched on word reading (e.g., Cardoso-Martins et al., 2002; Cossu et al., 1993; Snowling et al., 2002) and compared to their own phoneme manipulation skills (e.g., Cardoso-Martins et al., 2002; Snowling et al., 2002). However, performance on phoneme manipulation tasks is variable with some tasks more challenging than others (e.g., Fletcher & Buckley, 2002; Snowling et al., 2002). A particular difficulty with segmenting has been reported compared to blending (Fletcher & Buckley, 2002). A difficulty with identifying sounds in words is supported by the evidence that individuals with DS have particular difficulty with detecting final sounds compared to initial phoneme detection, which was not significantly impaired (Snowling et al., 2002). This is likely to be impacted by the verbal short-term memory difficulties and ill-defined phonological representations that individuals with DS have (e.g., Jarrold et al., 2009). If asked to hold a novel word in verbal short-term memory, whilst performing a phoneme manipulation task, the novel word may not be heard or held in the phonological loop accurately, impacting performance. Further, if asked to manipulate the phonemes in a familiar word for which an inaccurate phonological representation exists in the lexicon, all sounds may not be present/accurate to be manipulated. A meta-analysis (Næss, 2016) compared the typical development of phonological awareness to the development of these skills in individuals with DS. The author highlights the dependence on the final phoneme of both the rhyme and phoneme detection tasks in the Snowling et al. (2002) studies, concluding that individuals with DS are less aware of word endings. This is supported by individuals with DS frequently omitting final consonants (e.g., Dodd, 1976; Stoel-Gammon, 1980). This evidence further supports the vulnerability with morphosyntax for individuals with DS.

Given the intellectual impairments associated with DS and the evidence that reading is dependent on phonological skills (e.g., Rack et al., 1993) it might be expected that individuals with DS achieve limited reading skills. Although reading levels vary widely, studies suggest that around 90% of children with DS in mainstream schools develop measurable levels of reading (see Burgoyne et al., 2014). In terms of intellectual

ability, it has been argued that learning to read has relatively little to do with IQ but rather is dependent on phonological skills (e.g., Hatcher & Hulme, 1999, Stanovich, 1991; Stanovich & Siegel, 1994), although IQ plays an important role in reading comprehension (e.g., Hatcher & Hulme, 1999).

Phonological skills, including decoding (working out an unfamiliar word based on grapheme-phoneme knowledge) are often below word reading levels in individuals with DS (e.g., Burgoyne et al., 2012a; Kay-Raining-Bird et al., 2000a; Kennedy & Flynn, 2003; Roch & Jarrold, 2008) demonstrating a sight word or logographic strength. One model of reading (Frith, 1985) suggests all children start with this logographic stage before moving into the alphabetic stage of reading (and eventually an orthographic stage, continuing to use skills from all stages). It has been suggested that individuals with DS remain in this logographic stage for longer, struggling with the phonological awareness-based skills to move into the alphabetic stage (Byrne, 1997). Other models of reading suggest a dual route (see Coltheart et al., 1993) which somewhat aligns with dual route mechanisms of language discussed later in Chapter 4 (4.4.2.2). In summary, written words that have been read and learnt are represented in an internal lexicon. This printed form is then retrieved from the lexicon in order to read it aloud, referred to as the lexical routes of reading aloud. A second non-lexical route then exists to successfully read aloud decodable non-words that follow lettersound spelling rules of the language. Words may be mispronounced until they are stored as lexical items (e.g., "pint" read as rhyming with "mint"). Evidence that individuals with DS have relative strength in irregular word reading (Roch & Jarrold, 2008) and are poor at nonword reading (e.g., Burgoyne et al., 2013; Roch & Jarrold, 2008) is in line with this whole word reading strength. A number of studies have focussed on training phonological awareness skills in individuals with DS (e.g., Burgoyne et al., 2013; Kennedy & Flynn, 2013; Goetz et al., 2007; van Bysterveldt et al., 2006; van Bysterveldt et al., 2009). Evidence supports that individuals with DS successfully learn these skills although generalisation to the spoken form (or related reading skills) is mixed (e.g., Kennedy & Flynn, 2013; van Bysterveldt et al., 2006; van Bysterveldt et al., 2009). Given the difficulties with phonological awareness, it has been argued that reading should be taught by teaching letter-sound correspondences to encourage the development of phonological awareness skills (Cossu et al., 1993).

2.4. Summary

The evidence discussed in this chapter, highlights the numerous cognitive, speech and language difficulties associated with DS. It also highlights a number of issues associated with health that need to be carefully considered (e.g., hearing, vision and phonological short-term memory) as they potentially impact later learning. For example, given the difficulties with hearing, phonological short-term memory, accurate phonological representations and speech associated with DS, the poor phonological awareness skills reported are not unexpected. However, in contrast, the relative word reading strengths reported are associated with the relatively spared visual memory. Chapter 5 discusses these factors further and how they are potentially associated with the deficits in morphosyntax reported for individuals with DS. This profile of relative strengths and difficulties informed the development of the intervention in the current study, which targets the use of a grammatical morpheme. First the development of morphosyntax in typical development is discussed together with the factors that impact acquisition.

3. The development of morphosyntax in typically developing English-speaking children and its measurement

The acquisition of grammatical morphemes takes place over several years, with English-speaking children initially producing words that are a single root morpheme (Brown, 1973). When children start to combine two and more words, inflectional morphology is initially omitted (e.g., "Mummy gone", "Daddy like book"). This is commonly referred to as the telegraphic stage of syntactic development (Whan Cho & O'Grady, 1997). Over time, the morphological structure of words begins to emerge (Whan Cho & O'Grady, 1997) although there is considerable debate around how morphologically complex words are represented and processed (Gagné & Spalding, 2021). The acquisition of bound grammatical morphemes (meaning bearing units that cannot stand alone as a word, for example, possessive -s in Mummy's, regular past tense -ed in walked) is complex and emerges over several years in typical development (Brown, 1973). Regular and irregular inflection play a central role in morphological theory (Blom, 2018). Irregular forms are thought to be acquired as single units initially (e.g., children, fell) until approximately two and a half years of age when errors start to appear in child language (e.g., *childs, *falled) (Brown, 1973; Slobin, 1971). However, there is considerable variability in the ages typically developing children acquire these morphemes (Lahey et al., 1992). These common error patterns have provided corroboration for numerous hypotheses on general language development and more specifically, morphological development. In this chapter, the development of morphosyntax in English-speaking children is reviewed, specifically focusing on the acquisition of grammatical morphemes. This informed the selection and design of assessments and therapy techniques used in the current study.

3.1. Factors that influence the development of morphosyntax

The factors that influence the development of morphosyntax are numerous and complex. Observation of child language development across languages has led to the identification of several phonological, semantic and cognitive factors impacting

morphological development (Whan Cho & O'Grady, 1997). It has been argued that mastering the correct use of morphology requires phonological abilities, articulatory planning and well-developed semantics (Blom, 2018). Research on the factors that influence the omission of inflectional morphonology have identified the role of sentence length, position of inflection within the sentence and phonological complexity of the inflection form to impact omission.

3.1.1. Phonological and articulatory factors

Syllabicity and allomorphic invariance play a role in the acquisition of bound grammatical morphemes (Whan Cho & O'Grady, 1997). If a morpheme takes the form of an additional syllable (e.g., present progressive -ing) rather than a single sound (e.g., plural -s), it is more salient within the speech stream. Many grammatical bound morphemes frequently take the form of a voiceless, high frequency phoneme (e.g., plural -s (socks /spks/), possessive -s (Matt's /mæts/), past tense form -t (looked /lukt/), third person -s (cooks /kuks)) which can be challenging to extract from continuous speech. It is important to note that all of the aforementioned grammatical morphemes are also produced as a voiced lower frequency phoneme (e.g., plural -s (balls /bɔːlz/), possessive -s (Mum's /mʌmz/), past tense form -d (crawled /krɔːld/), third person -s (flies /flaɪz/)). This then demonstrates the second phonological factor, allomorphic invariance. With a number of phonological forms being used to mark the same grammatical morpheme, the challenge of extracting a hard and fast rule is complicated.

The phonological complexity of grammatical morphology also plays a part in the development of morphosyntax. Phonological forms that require consonant clusters (e.g., kicks /kɪks/, hopped /hɒpt/) are more frequently omitted than forms that require single consonant addition (e.g., plays /pleɪz/, dried /draɪd/) (Marshall & van der Lely, 2007; Song et al., 2009). It is unclear as to whether the difficulty comes from the challenge of abstracting the information or articulating the information, but perhaps both play a role. Evidence that the position the word occurs in a sentence impacts morpheme omission, may shed some light on this question. Verbs in medial position are more at risk for morpheme omission than verbs in utterance final position (Hsieh et al., 1999; Song et al., 2009).

3.1.2. Semantic factors

There are also a number of semantic factors that influence the development of morphosyntax (Whan Cho & O'Grady, 1997). In addition to the above, phonological factors also impact semantics to play a role in grammatical morpheme development. As discussed, a single grammatical morpheme can take several phonetic forms, adding to the challenge of acquisition (e.g., plural /s/, /z/, /ɪz/). Furthermore, a single phoneme can mark several different grammatical meanings (e.g., plural -s, possessive -s, third person singular -s). Thus, the relationship between meaning and the homophonous form of bound morphemes is obscured, hindering the acquisition of grammatical markers.

In addition to this indistinct relationship between phonology and semantics, exceptions in the use of grammatical morphemes impact the development of morphosyntax. Irregular forms complicate the relationship between form and meaning, resulting in children learning a regular rule (i.e., for the RSPT) that cannot be applied consistently to irregular forms slowing the development of morphosyntax.

The final semantic factor concerns how easily identifiable the meaning of the grammatical morpheme is. For example, the meaning of plural –s is less abstract than the meaning of a tense morpheme and it appears earlier in typical acquisition. Whereas morphemes that result in minimal/no change to the meaning of a sentence (e.g., third person singular -s) are amongst the last to be acquired, thus demonstrating their additional challenge. These semantic factors all hinder the acquisition of the related grammatical morphemes.

3.1.3. Frequency

The frequency with which a grammatical morpheme occurs in the child's language input has also been suggested as a factor in the acquisition of grammatical morphemes. In addition to the previously discussed factors, Whan Cho & O'Grady, (1997) compared the order of acquisition to the frequency each grammatical morpheme occurs. The relationship between these factors and the order of acquisition in child language is shown in Table 1.

Table 1 The order of acquisition of grammatical morphemes and the factors associated with the acquisition of each morpheme

Morphemes	Factors					Frequency in parental speech	
	1	2	3	4	5	6	
Progressive -ing	+	+	+	+	+	+	Articles the, a
Plural -s	+	+	+	+	-	+	Progressive -ing
Possessive -s	-	+	+	+	-	+	Plural -s
Articles the, a	-	+	+	+	-	-	Auxiliary be
Past tense -ed	+	+	+	-	-	+	Possessive -s
Third person singular -s	-	+	-	+	-	-	Third person singular -s
Auxiliary be	-	+	-	+	-	-	Past tense -ed

(adapted from Whan Cho and O'Grady (1997))

Research has shown that more frequent forms of a grammatical morpheme emerge earlier. For example, for regular plural -s the /s/ and /z/ emerge earlier that the less frequent /ɪz/ form and similarly the RSPT forms /t/ and /d/ are acquired earlier than the less frequent /ɪd/. However, it has been argued that this could alternatively be an articulatory factor. Given the differing order of frequency and acquisition presented in Table 1, frequency does not appear to affect grammatical morpheme acquisition, or at least is not an overriding factor. However, whether frequency plays a more critical role for children who have difficulty with grammatical morpheme acquisition is less clear. A study comparing the use of past tense -ed in children with DLD (van der Lely & Ullman, 2001), found children with DLD used past tense with verbs of higher frequency compared to lower frequency, this pattern was not seen in the typically developing controls.

3.1.4. Summary of the factors that influence the development of morphosyntax

Considering the number of factors associated with the development of morphosyntax, it is likely that a combination of these factors influences its development.

3.2. Methods of measurement of morphosyntax

There are a range of tasks that can be employed to assess a child's morphology. Comprehension tasks include picture pointing tasks and grammaticality judgement tasks. Expressive tasks include recording a child's morphological development over time and tasks that aim to elicit a child's production of particular

^{1 =} frequent occurrence in utterance final position, 2 = syllabicity, 3 = a straightforward relation between form and meaning, 4 = few or no exceptions in the way it is used, 5 = allomorphic invariance, 6 = discernible semantic function, + = some form of the morpheme does

morphemes in naturalistic or more structured tasks. The current study targets one specific grammatical morpheme, the use of RSPT in English. In order to select the most appropriate measures for the intervention study with children who have DS, the benefits and limitations of these methods was reviewed.

3.2.1. Comprehension tasks

One of the most common type of tasks for assessing comprehension involves picture selection (Gerken & Shady, 1996). Such assessments are commonly used when assessing children for general comprehension difficulties and tend to assess a range of grammatical structures. Typically, the child is presented with a spoken sentence and asked to point to the correct picture presented with three distractors. They tend to include a very small number of bound morphemes (e.g., the TROG-2 only includes plurals, comparative -er and superlative -est) and unless the sentences are presented via a recorder, controlling prosody can be difficult and impact results (Gerken & Shady, 1996). Therefore, whilst a potentially informative initial screen, this type of test does not provide an in-depth assessment of bound morphemes or an effective way of measuring progress. Researchers typically develop bespoke measures which include contrasting the bound morpheme being investigated (e.g., the paint is spilling/the paint spilled). This contrast pairing raises issues with providing an appropriate number of distractors to limit the effects of chance, requiring a high number of stimuli and participants to overcome this (Gerken & Shady, 1996). Act out tasks are also commonly used in research, asking young children to act out a sentence with toys (e.g., the truck was bumped by the car). Whilst these tasks have been used to assess a number of grammatical structures (e.g., missing objects and subjects, relative clauses, pronouns) (see Goodluck, 1996) they are not suitable to assess past tense as it would be difficult to act out the alternatives in a different way (e.g., the car is bumping the truck/the car bumped the truck).

Grammaticality judgement tasks (e.g., the grammaticality judgement probe found in the TEGI (Rice & Wexler, 2001)) have also received considerable interest when measuring a child's understanding of the use of grammatical morphemes. Grammaticality judgement tasks ask children to judge whether sentences are well formed (grammatical) or not and therefore require metalinguistic abilities. Evidence from these tasks with older children (over 6 years) shows a similar pattern to that seen

in morpheme acquisition: those morphemes acquired earlier are successfully judged first in grammatical judgement tasks (McDonald, 2008; Rice et al., 1999). However, the metalinguistic abilities required are not present in younger children who are able to use these morphemes accurately. Preschool children often judge the sentence based on semantic content rather than grammaticality (deVilliers & deVilliers, 1972) which confounds results. Furthermore, older children frequently misjudge sentences despite using the morpheme accurately (e.g., Wulfeck et al., 2004). Therefore, grammaticality judgement tasks are limited in their use regarding measurement of bound morphemes in younger children and those with lower cognitive abilities.

Whilst bespoke comprehension tasks may help to reveal any discrepancy between what the child understands (or identifies as 'incorrect'), the lack of suitability for young children and/or those with language delays is problematic. In addition, the challenge of developing a valid and robust test for the RSPT morpheme is considerable. As the current study specifically targets the use of the RSPT, an expressive measure is potentially more informative.

3.2.2. Expressive tasks

3.2.2.1. Recordings/records at home

One of the first studies to chart morphological development over time was carried out by Brown (1973). Brown and colleagues obtained approximately two hours of spontaneous speech every two months, for three children between the ages of 2 and 4 years over a period of approximately two years. Brown identified that the sequence the children acquired grammatical morphemes was incredibly similar and this resulted in the commonly known developmental list of Brown's grammatical morphemes. Whilst often considered as the 'gold standard' of language sampling (Sealey & Gilmore, 2008) due to its sensitivity over standardised measures it has a number of associated drawbacks. This naturalistic collection of data is incredibly time consuming and therefore reduces the number of participants that can be included in studies using this type of measurement (Demuth, 1996). Also, this method is more suitable for longitudinal studies, rather than those measuring the effectiveness of an intervention over a relatively short period of time. With the need to elicit larger language samples, a quicker method is advantageous.

An alternative method is keeping a regular diary or record of the child's language development. This record is frequently kept by parent(s) which has obvious benefits, including cost and time. An additional benefit is that this method is more likely to capture a more reliable record of natural language across a wider range of everyday interactions. Parental report has been validated by a number of studies, showing that parent report correlated with scores on standard language measures, regarding recording expressive vocabulary development in typically developing children (e.g., Miller et al., 1995) and groups of children with language difficulties including late talkers (e.g., Thal et al., 1991), children with profound hearing loss and cochlear implants (Thal et al., 2007) and children with DS (Miller et al., 1995). However, lower correlations are reported for parental report and standardised measures of grammar (see Law & Roy, 2008) making this method less reliable for measuring morphosyntax.

3.2.2.2. Naturalistic elicitation tasks

An alternative measure is to elicit spontaneous language in a controlled environment, over a specific time. For example, for young children a play situation may be set up and the parent is asked to play with their child as they typically would at home. For adolescents and adults, a conversation/interview is often used. This interaction is recorded and can then be analysed in terms of the participants' language (e.g., child or adult with language difficulties) and the language used by the conversation partner (e.g., parent or interviewer). This method has its own limitations, with language samples affected by contexts, for example spontaneous play situations elicit shorter utterances than other interactions (Leadholm & Miller, 1992). They can also be less suitable for children with language difficulties as the use of questions by adults reduces utterance length and questions are used more frequently when a child has a language delay (Johnston et al., 1993) or an intellectual disability such as DS (Miles et al., 2006). Crucially, the naturalistic sample may fail to elicit a particular grammatical morpheme due to the situation; if asked to play with a set of toys, the use of past tense may not be elicited as the participants are focussed on the present.

3.2.2.3. Structured elicitation tasks

Structured elicitation tasks typically involve a more focussed format, with the aim being to elicit one or more specific targets. Some assessments aim to elicit a particular morpheme many times by using structured methods (e.g., various probes in the TEGI

(Rice & Wexler, 2001)). These tasks include published, standardised measures as well as bespoke assessments designed to provide the context for a particular target (e.g., retelling a previous experience to elicit the use of past tense). This type of task can either use real word targets or novel word targets as in the 'wug' test (Berko, 1958). Tests/probes such as the TEGI past tense probe (Rice & Wexler, 2001) aim to provide the obligatory context to elicit the regular and irregular past tense forms. This type of test can take into consideration the various productions of the particular morpheme targeted, ensuring enough obligatory contexts for all variations (e.g., /t/, /d/ and /rd/ for marking the RSPT). This type of task has benefits for accurately investigating the use of a particular morpheme(s). Therefore, it is suitable for capturing the difficulty and any improvements in a few morphemes (e.g., a target morpheme and a comparative morpheme) but would be lengthy to complete for a large number of morphemes.

Another elicitation task that researchers often use is a narrative retell task. A narrative is presented to the child and the child is then asked to retell the story. Narrative language samples have shown MLU to be a robust measure of morphological development for typically developing children up to approximately 5 years of age (Miller & Chapman, 1981). The story is often presented with pictures (particularly to children) and the child has these picture supports to prompt their retell. The use of pictures may play an equally, or even more important role for older children with intellectual abilities (Miles et al., 2006). This study compared typically developing children to a group of children and young adults with DS (12;10-21;0 years). The participants with DS produced longer utterances in narratives compared to conversation and when picture supports were provided. This type of language sample elicits a more spontaneous language sample (rather than answering questions such as "What has been done to the dog?" (RAPT, Renfrew, 1997)) and has been found to elicit longer utterances than in spontaneous play and answering specific questions (Stallnaker & Creaghead, 1982).

The use of narrative vs conversation sampling has been found to be comparable for typically developing children 2;11-5;8 years (Miles et al., 2006), collecting as naturalistic sample as possible within these constraints. Furthermore, narratives facilitate the production of grammatical morphemes (Leadholm & Miller, 1992)

including for those with delayed language (Sealey & Gilmore, 2008) and can be designed to include multiple examples of the morpheme(s) being targeted. There are still limitations in terms of providing obligatory contexts, particularly for the use of the RSPT (Sealey & Gilmore, 2008). For example, if the story is told in the past tense, the child may retell the story in the present tense, which would be an acceptable way to narrate a story. Elicitation of tense has been correlated with age; older children (mean age 6;8 years) were more likely to retell a story in the past tense than preschool children (Shapiro & Hudson, 1991). Whilst it has been argued that narrative tasks can provide a sample of language which may inflate the child's use of a grammatical morpheme compared to general speech (Wagner et al., 2000; Westerveldt et al., 2004; Wren, 1985), used in combination with a range of structured tasks to compare the child's use across various elicitation opportunities would be beneficial.

Finally, imitation tasks are frequently used to provide more detail of a child's knowledge of precise grammatical factors (Lust et al., 1996). Repeating sentences requires children to not only recall the sentence but more informatively, use their own language skills to repeat back with consistent morphosyntax. If a bound grammatical morpheme has not yet been mastered, children are unlikely to repeat it back but rather omit it, producing an immature form (O'Grady, 1997). Repetition tasks have been found to be reliable with typically developing children as young as 2 years and children with SLI as young as 2;6 years (Chiat & Roy, 2007). However, the efficacy of sentence repetition tasks with other populations with language and intellectual disabilities is unclear. This type of task may be less reliable for populations with specific phonological short-term memory difficulties such as children with DS.

In summary, expressive tasks potentially provide a more accurate measure of morpheme acquisition and can be used to assess morpheme use in a range of cognitively and linguistically demanding tasks. This allows small changes in morpheme use to be evaluated and has the potential to measure changes following intervention.

3.3. Measuring improvements in the use of morphosyntax

The most common method of measuring general morphological development is the calculation of the mean length of a child's utterances (MLU). MLU has historically been used in clinical practice and research, being reported as a 'global measure of language proficiency' and more specifically as a measure of grammatical or morphosyntactic complexity (see Dethorne et al., 2005).

However, the reliability and validity of the use of MLU as a measure of grammatical development with various age groups has been questioned (Klee & Fitzgerald, 1985; Rondal et al., 1987). In a study comparing the relationship between MLU and grammatical development for typically developing preschool children to a range of older children and adolescents with 1) DS (aged 51-67 months) 2) autism (61-108 months) and, 3) Fragile X syndrome (5-19 years) Scarborough et al. (1991) found that MLU frequently overestimated the morphological development of all groups with language difficulties. Further, this overestimation increases when MLU values exceeded 3.0. In fact, the children with DS omitted significantly more grammatical bound morphemes but produced more content words resulting in similar MLUs. If MLU was simply reported, it might be assumed that expressive language skills were similar which was clearly not the case. Therefore, an increase in MLU cannot be relied upon as an accurate measure of grammatical morpheme development.

Language samples require more in-depth analysis to identify the improvement in use of any particular morphemes. If an accurate measure of a particular morpheme (such as the RSPT in the current study) is required, language samples need to be analysed for an increase in the use of that particular morpheme in obligatory contexts.

To accurately judge whether a morpheme is used correctly, incorrectly or omitted, it is necessary to elicit utterances where the target morpheme is obligatory. Furthermore, to ascertain whether a grammatical morpheme is acquired, Paradis et al. (2003) suggest that a minimum of four obligatory contexts should be present to judge a child's use of morphemes. A measure of the use of a particular target can then be calculated as percentage correct in obligatory contexts (PCOC) (Paradis et al., 2003). Language samples can then be analysed in more detail to accurately calculate whether the percentage correct in obligatory context of a particular morpheme has improved. It is

common for researchers to develop a coding system based on their research question, which can be complex and effected by the method of sample elicitation (e.g., Sealey & Gilmore, 2008). In an attempt to overcome this challenge, bespoke stories can embed strategies to increase obligatory context e.g., asking prompt questions in the past tense when targeting RSPT. Also, a bespoke story can include a large number of opportunities for a particular morpheme to create enough obligatory contexts as well as reduce sentence complexity and processing demands (using simple sentences with pictures) to effectively assess whether a child can use a particular morpheme consistently. Therefore, it is important to select elicitation methods carefully as well as accurately identify, code and analyse a targeted bound grammatical morpheme in order to measure change.

In conclusion, MLU is considered a valid measure of general morphological development up to approximately 3.0 morphemes. However, children with language difficulties are often much older and produce longer strings of content words than typically developing matched controls. When measuring the improvement in the use of particular grammatical morphemes, it is more effective to use PCOC scores for the targeted bound morphemes.

3.4. Summary and implications for measuring morphosyntax in children with language difficulties and intellectual disability

It has been suggested that the use of a range of elicitation techniques should be used to provide a truly representative sample (Wren, 1985). Converging evidence from a number of different methods of elicitation provides the strongest evidence that grammatical competence has been tapped (Lust et al., 1996) and would demonstrate that a targeted bound morpheme had been acquired.

There are some measures of morphological development which are more suitable for measuring the effectiveness of an intervention aimed at improving the use of the simple past tense in children with DS. Some naturalistic measures discussed (e.g., recording the child's language development in their natural setting) are more suitable for longitudinal studies of general morphological development. A narrative retell has the benefit of collecting a more naturalistic sample, but needs to be carefully developed to elicit enough obligatory contexts for a particular morpheme (e.g., the

simple past tense). Structured elicitation tasks, such as sentence completion and sentence repetition can provide more obligatory contexts, although sentence repetition has additional implications for children with working memory difficulties. The use of pictures to provide context goes some way in limiting working memory demands. Further support for this method comes from research showing story retell, with the use of pictures, results in richer language samples for children with DS. Therefore, this would be an appropriate strategy to include in a narrative retell. This context may also overcome some of the difficulties with intelligibility associated with DS. Therefore, a combination of a bespoke story retell (targeting multiple examples of the RSPT) and more structured elicitation tasks, both with pictures, may elicit the appropriate language data.

It is particularly important to consider including bespoke measures when assessing children with language difficulties and intellectual disabilities. The use of standardised measures of expressive and receptive language for young children can be problematic, predominantly due to the limited language measures available for this young age group (Law & Roy, 2008). Given the similarities between language data from younger children and those with language difficulties, careful consideration is required when selecting suitable measures and the use of a range of elicitation techniques is even more crucial.

The use of additional bespoke measures can potentially be used to increase sensitivity and accurately measure the use of a bound grammatical morpheme at a single timepoint or to pick up smaller steps of progression over time. When developing bespoke measures to test the acquisition of a particular bound grammatical morpheme, such as RSPT in the current study, the phonological and articulatory factors influencing grammatical morphological development must be carefully considered. The strength of PCOC scores has been discussed, including the necessity of at least four obligatory contexts. The various forms the RSPT grammatical morpheme takes in English (i.e., /t/, /d/ and / ɪd/) may impact acquisition. For example, a child with hearing difficulties may find the /t/ form more difficult to access and this may confound results if only /t/ forms are assessed. In addition, when adding the grammatical morpheme to those ending in a consonant other than -t or -d, a cluster is formed (e.g., /lukt/), kro:ld/). A child with articulation difficulties may then be

unsuccessful in producing those forms with more challenging forms, again confounding results. Therefore, ensuring the enough elicitations of the range of forms to allow a score of PCOC becomes even more important when measuring morphological development in those with hearing and speech difficulties.

A range of bespoke and published measures including structured tasks (i.e., imitation and structured elicitation), as well as more naturalistic tasks that provide the required number of elicitations in obligatory context (such as bespoke story retell) were considered to provide strong evidence of acquisition. This would also potentially increase the data that could be analysed for PCOC scores, providing more information on the use of a particular bound morpheme targeted in intervention.

4. Development of the simple past tense

The current intervention targeted the RSPT in English-speaking children who have DS. Therefore, this chapter focuses mainly on the development of this tense in English, but where relevant, will refer to other tenses and languages. This chapter covers the development of the regular past tense in typically developing children and the factors that impact this development, before turning to children with Developmental language disorder (DLD) and how difficulties with tense have informed accounts of the development of the regular past tense and its assessment.

4.1. What is tense?

Tense conveys events along a timeline in English (Mithun, 2019) and requires three temporal systems, 1) speech time, the point in time an utterance is spoken, 2) event time, the time established in relation to the speech time (simultaneously, before or after) and 3) reference time, which is the temporal context provided (Weist, 1986). For example, in the sentence Isabelle arrived late for school yesterday – the event time occurs before speech time as shown by the past tense morpheme -ed, and the time adverbial yesterday specifies the context. It is important to note that reference time may be understood based on the speaker's joint knowledge, rather than explicitly marked as in the example. Very young children (1;6-3 years) are able to speak about events in the past as well as the present (Owens, 2019), which demonstrates their understanding of the concept of time although the grammar is yet to be acquired. They are required to work out how to mark this concept of tense, according to their native language and in English the relationship between tense and time is subtle and not straightforward (Huddlestone & Pullum, 2005). For example, past tense forms can be used for events that have not even taken place (e.g., I wish she had told me about it earlier). Whilst English has a relatively small number of grammatical morphemes, they are used to express a range of meanings. This increases the challenge for young children who must work out the rules for marking relevant grammatical contrasts in English.

Tense can be marked by morphemes attaching to the stem of the verb (e.g., -ed, -s) as well as on free morphemes such as the auxiliaries be and have, (she was running;

she had arrived) and on copular verbs (he was a student). A number of morphemes that carry tense, also carry agreement e.g., number (the boy jumps, the boys jump) and person (I jump, he jumps) (e.g., Pinker, 1999). In comparison, the simple past tense does not involve agreement (unlike the simple present tense), which is potentially less complex and contributes to its earlier acquisition. The fact that the pattern for the simple present tense varies depending on the required agreement, potentially increases the challenge for young children.

In contrast to English, which has a relatively impoverished inflectional system, many languages have much richer inflectional systems. Italian for example, requires all verbs to be inflected for person and number. In addition, nouns and adjectives are inflected for gender and number. These inflections are mainly syllabic, making them more salient than those in English and this, together with the increased number of inflections, is thought to result in far fewer difficulties with tense in Italian (Leonard et al., 2002).

English requires the morpheme *-ed* to be added to the main verb stem of regular verbs (e.g., the boy jumped) or learning the irregular form (e.g., the boy ate). Tense is also marked on the auxiliary verb which results in the main verb taking the progressive morpheme -ing (e.g., Isabelle was jumping/laughing). As other auxiliary verbs are acquired, they are similarly marked for tense (have, do) and the main verb is marked for aspect (which refers to temporal characteristics such as duration, completion, punctuality, inception and iteration (Aksu-Koç et al., 1988)) (e.g., the baby was crawling, she had eaten her dinner). It is important to note that firstly the past participle form can also take the -ed morpheme (e.g., Isabelle has walked), but this is not the case with irregular verbs (e.g., Isabelle had eaten/written) and secondly that, in this instance, the main verb is not marked for tense. Tense is instead marked on the auxiliary have (e.g., Isabelle has arrived/Isabelle had arrived). In addition, these auxiliaries are unstressed and frequently take a contracted form (she's, they'd) reducing their salience in the speech stream. This combination of factors highlights the complicated task young children are faced with and these varied and complex patterns are potentially why the simple past tense (which does not carry agreement) tends to be acquired before these other forms in English.

The simple past tense is marked on the main verb and in English, verbs are either regular (e.g., walk, crawl) or irregular (e.g., eat, fall). Regular verbs are inflected for past tense with the morpheme -ed (e.g., the baby crawled) or present tense with the morpheme -s (e.g., the baby crawls). Regular verbs are abundant in English, in fact, when new verbs are added to the English language, they invariably take the regular form (e.g., zoomed, tweeted) (Pinker, 1994). Irregular verbs are far fewer, approximately 180, although many of these are not used today (Pinker & Ullman, 2002). These verbs take a less obvious and uniform pattern (e.g., ate, fell, drank). Although there are some patterns to irregular verbs (Pinker, 1994), their origins are no longer present in the modern English language. Therefore, irregular verbs are thought to be learnt as single lexical items, in the same way as nouns (Bybee & Slobin, 1982). Whilst irregular verbs are fewer in number, they are amongst the most frequently used verbs in English (Bybee & Slobin, 1982).

4.2. The development of regular and irregular past tense

Children first produce single words, and these words rarely include past tense forms (e.g., *ate, walked*) (Owens, 2019). Children may talk about past events but omit tense markers (Rice & Wexler, 1996). Two-word utterances typically emerge around 18-26 months, following an increase in the number of verbs a child has acquired (Bloom & Lahey, 1978). The combination of words generally occurs when a child has at least 50 words and these words are learned as single lexical items (Bybee & Slobin, 1982). At approximately 2;6 years, children begin to emerge from the *telegraphic stage* of syntactic development (Whan Cho & O'Grady, 1997) and past tense forms begin to emerge (Brown, 1973), although mastery (90% correct use) does not occur until approximately 3-5 years (Owens, 2001). Past and present tense appear earlier than the ability to talk about the future (Owens, 2019).

Irregular forms are historically considered to be the first verb forms to be acquired (e.g., went, saw) (Brown, 1973; deVilliers & deVilliers, 1973). However, more recently it has been reported that whilst some common irregular verbs are acquired between the ages of 3-4;5 years (e.g., hit, hurt, went, saw), others are still not acquired until as late as 8-8;11 years (e.g., hung, sent, shook, built) (Shipley et al., 1991). Irregular forms typically occur with high frequency in the language (Brown, 1973) and it is

perhaps this frequency that is, at least in part, responsible for their early acquisition. The phonological environment has also been suggested to impact acquisition. For example, Shipley et al. (1991) reported that the two irregular forms amongst the last to emerge were those marked with final consonant change from /d/ to /t/ (e.g., build-built) and those with an internal vowel change and final alveolar consonant (e.g., ride-rode). Similarly, verb endings were more frequently omitted from irregular and regular novel verbs that ended in an alveolar consonant in a study by Marchman (1997). One possible reason suggested for this is that children resist marking inflections when the verb stem already ends in a phoneme commonly used to mark regular past tense –ed (i.e., an alveolar plosive). Irregular verbs are thought to be 'rote-learnt' as single lexical items (Bybee & Slobin, 1982) and therefore are likely to be impacted by how frequently the child is exposed to the word and the phonological complexity of the form. In summary, several factors including frequency and phonological environment are believed to interact in the acquisition of irregular forms (MacWhinney, 1978; Shipley et al., 1991; Slobin, 1971).

Regular past tense forms also begin to appear at the same stage as irregular verbs (Reed, 2012), but their use fails to reach the 90% accuracy required to receive the recognised acquisition status until later (Brown, 1973; Owens, 2019). It is suggested that during this early phase, these regular past tense forms are learnt as whole words like irregular verbs (Reed, 2012). Over time, it is recognised that children start to apply their knowledge of past tense *-ed*, demonstrated by their ability to apply this *-ed* 'rule' to new/novel verbs. The most convincing evidence for this comes from the overgeneralisation of the RSPT rule i.e., children's production of forms such as *eated and *runned. These are forms that the child would be unlikely to come across in their language input and therefore they cannot have been learnt as single lexical items. Errors of overregularisation such as these provide evidence that children are becoming more aware (albeit unconsciously) of the patterns or 'rules' underlying language, rather than simply learning words as single lexical items. These errors frequently occur in place of previously correct irregular forms the child was using. Over a period of weeks or months these errors of overregularisation on familiar irregular verbs begin to dissipate as the child masters regular and irregular past tense forms (Owens, 2019). Whilst on the surface, the application of the regular past tense rule might seem simple, it is complex and impacted by a number of factors.

4.3. Factors affecting the development of regular simple past tense forms

As discussed above, the RSPT is marked on regular verb forms by the addition of the grammatical morpheme *-ed*. There are a number of linguistic, phonological and processing factors that impact the development of the RSPT as discussed below.

4.3.1. Linguistic factors

The development of a child's linguistic knowledge is an important factor influencing the acquisition of tense. It has been argued that English-speaking children only use lexical categories initially (Braine, 1963) and this reflects brain maturation (e.g., Wexler, 1994) or general learning mechanisms (e.g., Tomasello, 2000). However, although young children may only use lexical categories in this early stage, it is argued that they are aware of the functional categories as evidenced by sucking patterns in children only a few days old (Shi et al.,1999). Evidence such as this supports the argument that some components of grammar must be innate (Chomsky, 1986). There have been a number of studies looking at when young children start to become aware of grammatical morphemes, rather than analysing words as a single whole lexical item. Children as young as 18 months show a preference for grammatical sentences containing the auxiliary be followed by continuous -ing compared to ungrammatical sentences (auxiliary can followed by continuous -ing) (Santelmann & Jusczyk, 1998). In addition, Soderstrom (2003) found that the 19-month-olds in their study, preferred passages that include the morpheme -s (plural and possessive) to those where the morpheme was omitted. One study concluded that children as young as 6 months were able to segment grammatical morphemes, showing an awareness between inflected and noninfected forms (Kim & Sundara, 2021). Therefore, evidence suggests that typically developing children already have some phonological representations of several grammatical morphemes within the first year of life.

Although young children appear to be aware of tense morphemes from an early age, they are initially omitted in English. It has been argued that omissions of tense reflect a grammatical competence (or lack of), and that, at this stage, they are unaware that tense is an obligatory factor (e.g., Rice & Wexler, 1996). Initially children omit *-ed* from the main verb, producing an infinitive form (which occurs in a form homophonous to other forms in English that are otherwise grammatical e.g., *I jump*). Thus, this stage is

known as the optional infinitive stage (Wexler, 1994). Children in this stage are suggested to know the properties of finiteness but fail to use it. This is supported by the inconsistency of correct use; the child may use a grammatical marker or omit it (e.g., Isabelle jumped/*Isabelle jump, Isabelle was jumping/Isabelle jumping) but rarely do they produce an error (*Isabelle were jumping). A biological based maturation principle is given as the basis for this theory (Wexler, 1994), with children achieving an adult like grammar by the time they reach approximately 5 years (Leonard, 2014).

Following early learning of words as single lexical items, the child starts to develop their knowledge of grammatical morphemes as disparate units to verb stems. As discussed in Chapter 3, several different morphemes can take the same phonological form (e.g., plural -s, possessive -s, third person singular -s) and this impacts acquisition. Regular past tense -ed does not involve this overlap which may contribute to its early development as a tense morpheme. It is however, complicated by the opposing irregular form resulting in the errors of overregularisation discussed above. In addition, lexical frequency is a factor influencing the development of the RSPT. Regular words that occur more frequently are marked with the RSPT inflection more consistently by children under 4 years (Oetting & Horohov, 1997) and older 7-year-olds (Matthews & Theakston, 2006). The suggested reason for this is that the more frequently the word is heard, the more its representation in memory increases and this improves accessibility (Rispens & de Bree, 2014).

4.3.2. Phonological factors

Phonological factors are suggested to also play a role in the development of the regular past tense (Marchman, 1997; Oetting & Horohov, 1997). Regular inflected forms are phonologically similar (e.g., *crawl* and *crawled:* /krɔːl/ vs /krɔːld/) reducing the salience of the past tense -ed. This is further compounded when the verb occurs mid-sentence and is followed by a word beginning with the same phoneme, making it less salient (e.g., *Isabelle crawled down the stairs:* /ɪzəbel krɔːld daun ðə stɛəz/). When this occurs, the past tense morpheme is harder to detect, increasing the challenge of mastering regular past tense. However, despite this challenge young children are successful, although this mastery takes time and other phonological factors play an important role.

Children omit the regular inflection -ed more frequently on regular verbs that end in an alveolar consonant (Marchman, 1997). One possible reason is the resistance to mark inflections on verb stems that already end in the regular -ed form /t/ and /d/ (e.g., bat, mend). However, the pattern is more complex, as it is not only verbs that end in the alveolar plosives that are omitted. Verbs ending in fricatives (e.g., close, push) are also less frequently marked for past tense by typically developing children (mean age 3;10 years) than those ending in vowels and liquids (e.g., cry: /kraɪ/, crawl: /krɔːl/) (Oetting & Horohov, 1997). This study fails to note that phonetically, the English verbs included in the study did not end in glides, but all ended in vowels (e.g., play: /pleɪ/, chew: /tʃuː/). Marshall (2005) highlighted that the original Oetting and Horohov (1997) study fails to note that regular past tense inflection does not result in a cluster for verbs ending in vowels in English. When the regular past tense -ed is applied to verb stems that end in a fricative or a stop (e.g., dance /dɑːns/, hop /hpp/) a cluster is required causing an additional articulation challenge (e.g., danced /dɑːnst/, hopped /hppt/).

Articulation of the past tense *-ed* is also a consideration in RSPT development. Voiceless stops (i.e., /t/) are typically acquired before voiced stops (i.e., /d/) in coda position (Kehoe & Stoel-Gammon, 2001) and the same has been found for the fricative /s/, with its counterpart /z/ acquired later. It has therefore been argued that voiced clusters (e.g., *stands*) would be acquired after voiceless clusters (e.g., *skips*) (Tomas et al., 2015; Song et al., 2009).

Given the challenges with the phonological form created by the addition of /t/ and /d/ to verb stems, it might be expected that the additional syllable /ɪd/ form (e.g., waited /weɪtɪd/) would appear earlier. In addition to the articulation challenge, the acoustically non-salient /t/ and /d/ forms make the RSPT morpheme more difficult to process, particularly for those who have difficulty developing accurate phonological representations (Joanisse & Seidenberg, 1998).

However, despite this increased salience, past tense verb forms that take an additional syllable (e.g., waited /weɪtɪd/) are suggested to be acquired later than single syllable verb forms (e.g., crawled /krold/) (Berko, 1958; Brown, 1973). For the RSPT, this is potentially due to the /t/ and /d/ forms occurring more frequently in English resulting in the later acquisition of the /ɪd/ form. This is supported by the similar frequency effect

seen in the acquisition of regular past tense forms requiring a cluster (e.g., Marchman, 1997). In English, whilst many regular verbs end in frequently used clusters in the language (e.g., danced: /da:nst/, hopped: /hppt/), many end in less frequently used clusters (e.g., hugged: /hʌgd/, slammed: /slamd/) (Marchman, 1997). These less frequent phonological forms therefore appear low in terms of frequency in English, which Marchman (1997) argues impacts acquisition. Therefore, past tense production may be impacted by frequency of the individual verb, the particular grammatical morpheme (Nicoladis et al., 2007; Plunkett & Marchman, 1996) and the phonological form (Marshall & van der Lely, 2006).

4.3.3. Processing limitations

In addition to linguistic and phonological factors, it has been hypothesised that the processing limitations of the child will impact broad language learning and result in specific areas of weakness including the development of morphology (Leonard, 2014).

Young children (3;0 to 4;8 years) are more likely to omit tense related grammatical morphemes when argument structure complexity is increased in story completion tasks (Grela & Leonard, 2000). The authors suggest that this is partly due to limited processing capacity resulting in tense being more vulnerable due to grammatical morphology being less well established in children's grammar. This results in a lack of capacity left to retrieve auxiliaries and potentially other morphemes relating to tense which are not consolidated. The successful use of tense in utterances with fewer arguments suggests that by this age, children understand and have acquired this tense morpheme, but it is the processing demands of the task that impacts performance.

This is further supported in grammaticality judgement tasks where sentence length and complexity has been found to influence the use of grammatical morphology (specifically third person singular -s) with children dropping inflections in longer and more complex sentences (Song et al., 2009) whilst exhibiting more consistent use in shorter tasks. One study (Hayiou-Thomas et al., 2004) demonstrated that adding cognitive stress factors (compressing the speech signal) or increasing memory load (adding verbiage to the sentence), impacted the performance of typically developing

children (5;8-7;2 years) on grammaticality judgement tasks. Specifically, noun morphology judgements (plural -s) remained unaffected whilst verb morphology judgements (past tense -ed, third person singular -s) were significantly impacted by speed and length. It has therefore been suggested that these factors will further impact younger children who have limited cognitive resources (Blom, 2018).

Again, this is not a straightforward relationship, as the omission of morphemes is also impacted by the position within a sentence. Young children use verb morphology at the end of an utterance at higher rates than in the middle of the utterance. Although the reason for this is unclear, it has been suggested that there is less time for planning and articulating the sounds in utterance medial position due to the limited words before the verb and the constraining words following the verb (Blom, 2018). Therefore, inflectional morphology associated with verbs in final position is less frequently omitted. The evidence of using grammatical morphemes more consistently at the end of an utterance would suggest that it is in part the speed of processing and planning articulation that is impacting the grammatical morphology midsentence rather than evidence the child has not acquired a morpheme. If the later was the case, the use of the morpheme in all utterance positions would be impacted.

4.3.4. Summary

In summary, there is a vast literature examining the factors affecting the development of the RSPT. It is a complex challenge, impacted by a number of interacting morphological and phonological factors (Rispens & de Bree, 2014), but achieved by the majority of children by 5 years (Owens, 2001). One group of children who find this challenge particularly formidable are children with DLD, and they have received considerable attention in attempts to understand language acquisition.

4.4. Specific difficulties with tense – children with Developmental language disorder

4.4.1. Developmental language disorder

Children with DLD have difficulties with language in the absence of intellectual disability, hearing impairments, neurological damage or autism (Leonard, 2014). In

2016 the term DLD was introduced as the "best fit" term to describe people with significant language difficulties that are likely to have lifelong impact (RCSLT, n.d.). Prior to this, the term Specific Language Impairment (SLI) was used. In this thesis, the current term DLD is used throughout to describe this population.

The prevalence of DLD in children is approximately 7% (Leonard, 2014) and these children experience delays in language development early on, with a delay in the emergence of words and word combinations (Leonard, 2014). Whilst children with DLD commonly experience difficulties with vocabulary, phonology and pragmatics, morphosyntax is reported to be most significantly impacted (Leonard, 2014). The grammatical morphology of children with DLD has received particular interest, due to the specific difficulties experienced by this group. Studies comparing language samples of children with DLD to younger typically developing children matched on MLU report similar use of lexical types (Leonard et al., 1982) and semantic and syntactic structures (Johnston & Kamhi, 1984). It has been reported that tense is a specific challenge for this group of children and can even be considered a clinical marker of DLD (e.g., Conti-Ramsden et al., 2001; Rice & Wexler, 1996). It is recognised that children with DLD with a mean age of 5;1 years understand the concept of time and in fact perform similarly to younger children (mean age 4;2 years) in their use of time adverbials whilst frequently omitting regular and irregular forms (Moore & Johnston, 1993). The authors therefore concluded that children with DLD have an understanding of time and subsequently the weaknesses with *-ed* are due to specific difficulty with how concepts of time are marked by tense morphology.

A meta-analysis by Kan & Windsor (2010) confirmed that children with DLD have difficulties learning verbs compared to typically developing children and in comparison to their own learning of nouns. Children with DLD use a more limited range of verbs, although overall lexical diversity is comparable (Watkins et al., 1993). They also frequently omit and substitute verbs unlike typically developing children (Chiat, 2000; Rice & Bode, 1993). There are a number of reasons suggested as to why verbs are acquired later. According to Owens, (2019), verbs are challenging for all children due to 1) the concepts they refer to are abstract and difficult to interpret from the physical environment (e.g., *throwing* vs *catching* requires association with origin or final location, compared to the concept of *ball*), 2) they can appear very different (e.g.,

running looks different in an athlete, toddler, elderly person, animal), 3) can be fleeting (e.g., throw, hit), 4) can also be nouns (e.g., drink, brush). In addition, Black & Chiat (2003) highlight the differences in 1) the phonological form, verbs tend to have a less typical stress pattern and relatively shorter durations in sentences than nouns, and 2) the linguistic demands, verbs are associated with more complex argument structures. Babies are able to segment nouns as young as 6 months (Bortfeld et al., 2005) but verb segmentation does not occur until 13 months (Nazzi et al., 2005). Given the nature of the relationship between verbs and tense morphology, it would appear that from early on, children with DLD are at a disadvantage.

More recently, research has focussed on phonological factors associated with morphological difficulties observed in children with DLD. As discussed in the previous and current chapters, phonological and articulation factors associated with bound morphemes impacts acquisition for all children. It is hypothesised that this produces even more of a challenge for children who are already struggling to master grammar. If phonological factors such as salience are playing a role as suggested (Marchman, 1997; Oetting & Horohov, 1997; Riches, 2015), it would be logical to expect that children with DLD, who often have difficulty with phonology (Leonard, 2014), would be disadvantaged when extracting this information from the speech stream.

Studies often report assessing participants on a selection of monomorphemic words that end in the phonemes required to mark tense (e.g., boat for /t/, red for /d/, bus for /s/, nose for /z/). However, as highlighted by Leonard et al. (1997), many fail to consider the articulation of the more complex phonological clusters caused by the addition of -ed (e.g., Hilvert et al., 2020; Rice & Wexler, 1996). Whilst children with DLD generally do not experience difficulties with articulation for known words, many have difficulties with clusters, which can result in omitting the grammatical markers, particularly for complex syllable structures (Gallon et al., 2007; Leonard et al., 1988). In fact, grammatical morphemes that are subject to phonological processes (e.g., cluster reduction, final consonant deletion) have been suggested to cause difficulties due to this reason (Leonard et al., 1988).

Researchers focussing on phonological difficulties in DLD have studied these articulation factors. One study (Marshall & van der Lely, 2009) investigated the effect of increasing cluster length by comparing children's use of the RSPT form for: 1) verbs

that only required the addition of a final consonant 2) verbs that required two consonants, and 3) verbs that required more than two consonants. For typically developing children, production of the RSPT was not influenced by the cluster complexity. However, children with DLD demonstrated a pattern of increasing omissions as consonant cluster complexity increased.

Frequency of cluster use in non-inflected words seems to affect the use of the RSPT by children with DLD more than typically developing children. Children with DLD have been shown to produce inflected forms (e.g., *rolled*) more frequently when the same clusters also appear in monomorphemic words (e.g., *hold*) than those that rarely appear in monomorphemic words (e.g., /gd/ in *hugged*) (Leonard et al., 2007; Marshall & van der Lely, 2006). This difference was not seen for younger controls.

In addition to the linguistic and phonological factors impacting morphological development in children with DLD, limitations in processing capacity and verbal memory deficits have been suggested as underlying processing factors (e.g., Eadie et al., 2002; Plante & Gomez, 2018; Ullman, 2004; Ullman & Pierpont, 2005). Verbal memory deficits include deficits with short-term memory, working memory and long-term memory.

Learning words is believed to rely on phonological short-term memory (e.g., Baddeley et al., 1998; Gathercole & Baddeley, 1989) and deficits in this short-term memory component can result in inaccurate phonological representations being stored in long-term memory. Children with DLD have been found to have deficits in phonological short-term memory compared to visuospatial short-term memory (e.g., Archibald & Gathercole, 2006). In addition, deficits in memory systems associated with long-term memory are reported, including explicit/declarative memory (e.g., Lum et al., 2015) and implicit/procedural memory (e.g., Gathercole & Baddeley, 1990; Lum et al., 2012, Ullman & Pierpont, 2005). However, some studies report no evidence of deficits in explicit memory (e.g., Lum et al., 2012). One study compared children with DLD who had deficits in working memory (approximately 75=80% of the group) to a second group of children with DLD who did not demonstrate working memory deficits (approximately 20-25%), demonstrating the prevalence of working memory difficulties associated with DLD. This second group performed similarly to a group of typically developing children on an explicit memory task involving encoding and retrieval of

verbal information (all groups had similar nonverbal mental ages in line with chronological age). The authors reported that the group with DLD who did not experience working memory difficulties, showed no significant difference in performance compared to the typically developing group. In contrast, the group with DLD and working memory deficits scored significantly worse on encoding and retrieval after a delay. They concluded that working memory may be responsible for the perceived deficits reported regarding explicit memory, which may be relatively intact.

Children with DLD demonstrate poor performance on nonword repetition tasks (e.g., Bishop et al., 1996; Conti-Ramsden et al., 2001) and sentence repetition tasks (e.g., Briscoe et al., 2001; Conti-Ramsden et al., 2001; Eadie et al., 2002; Laws & Bishop, 2003). It is argued that long-term memory plays some part in word/nonword repetition, with recall of words higher than recall of nonwords (e.g., Hulme et al., 1991) and higher recall of frequently used words in the language compared to those infrequently used (e.g., Hulme et al., 1997). However, long-term memory and linguistic factors play a more important role in sentence repetition; when recall of a string of words is compared to a sentence of the same length, sentences are more accurately recalled due to the semantic and syntactic knowledge of language (see Archibald & Joanisse, 2009). Unlike nonword repetition, sentence repetition has been found to link to short-term memory (e.g., Conti-Ramsden et al., 2001), vocabulary (e.g., Stokes et al., 2006) and grammar (e.g., Eadie et al., 2002). If the phonological representations of words are inaccurate and/or the syntactic knowledge is not yet mastered, it is reasonable to expect these factors will impact sentence repetition. Sentence repetition has therefore been argued to be a useful clinical marker of DLD (e.g., Archibald & Joanisse, 2009; Riches, 2012) as it captures children with DLD omitting these crucial components of language (e.g., Leonard et al., 1992b; Chiat & Roy, 2008). Whilst sentence repetition may be an appropriate assessment tool for uncovering the deficits in the use of grammatical morphemes, it is the omission of these morphemes that remains the underlying pattern distinguishing children with DLD from their typically developing peers.

Although there is debate in the literature about the heterogeneity of children with DLD (see Lancaster & Camarata, 2019), studies agree that this group have difficulty with tense (e.g., Leonard et al., 1997; Oetting & Horohov, 1997; Rice & Wexler, 1996; Rice

et al., 1995). A study by van der Lely (1994) identified a group of children with DLD who had specific difficulty with grammar compared to other areas of language. This group are defined as having a "primary deficit of the computational grammar system" and thus have been termed Grammatical (G)-SLI (van der Lely & Ullman, 2001, p. 178). Van der Lely (2005) argued that whilst some children with DLD have a broad language difficulty, there exists a subgroup of children with DLD who primarily have a deficit in grammar (with other domains of language within the normal range). A longitudinal study (Rice et al., 2000) found that children with DLD fell below a younger group matched on language on the use of regular past tense -ed. However, the group with DLD performed similarly to a chronological age matched group in the use of irregular past tense forms. Whilst it is generally agreed that children with DLD have a relative strength in irregular verbs (e.g., Rice et al., 2000; Rice et al., 2002), some studies have reported children with DLD experience more difficulty than their age matched peers (e.g., van der Lely & Ullman, 2001). One study compared regular and irregular past tense forms of a group of children with G-SLI to younger groups matched on 1) morpho-grammatical abilities (including tests of grammatical ability as well as lexical-conceptual knowledge), 2) receptive vocabulary, and 3) expressive vocabulary (van der Lely & Ullman, 2001). They found that the G-SLI group performed similarly in their use of irregular past tense forms to the group matched on morpho-grammatical abilities, producing fewer irregular forms than the vocabulary matched groups. The G-SLI group also demonstrated frequency effects for irregular and regular forms. The authors concluded that the irregular past tense forms (learnt as single lexical items) appear a relative strength for children with DLD and hypothesise that the frequency effects suggest that they are also learning regular forms in the same way. This is unlike typically developing groups, who are generating the regular form by applying their knowledge of the relevant morphological rule. This relative strength in the use of irregular past tense (Rice et al., 2000) and the use of time adverbials (Moore & Johnston, 1993) demonstrates a general understanding of concept of time, suggesting there is a difficulty with grammatical morphology impacting the use of tense for this group.

Children with DLD experience difficulties with bound morphemes (past tense -ed, third person singular -s) and free morphemes (articles and auxiliaries) (Eadie et al., 2002; Rice & Wexler, 1996). The common pattern of errors exhibited by this population is

omission; children omit the required morphology, rarely applying 'incorrect' morphology (Rice et al., 1995; Rice & Wexler, 1996). This is the same pattern as observed in younger typically developing children, before the relevant morpheme is acquired.

4.4.1.1. Difficulties with tense vs non-tense morphemes

Whether children with DLD have difficulties with morphemes in general or specifically tense morphemes is an important question, as not all grammatical morphemes appear equally vulnerable to the "linguistic deficit characteristic of English-speaking children with SLI" (Sealey & Gilmore, 2008, p.224). It is widely recognised that children with DLD have specific difficulty with bound and free tense morphemes compared to children matched on chronological age (e.g., Norbury et al., 2001; Rice et al., 1995; Rice & Wexler, 1996) as well as younger children matched on MLU (e.g., Eadie, et al., 2002; Hilvert et al., 2020; Kaderavek & Sulzby, 2000; Rice et al., 1995; Rice & Wexler, 1996; Oetting & Horohov, 1997) and receptive vocabulary (e.g., Norbury et al., 2001). These difficulties with tense morphemes are observed from the age of 5 years (when typically developing children have mastered the regular past tense (Owens, 2001)) and this persists into later childhood (van der Lely, 2005) and adulthood (Leonard, 2014).

The comparison of the use of tense related morphemes to non-tense related morphemes has received much attention within this field. Non-tense related morphemes include bound morphemes (e.g., plural –s, progressive –ing) and free morphemes (e.g., articles the and these). There is mixed research on the use of articles by children with DLD. Whilst some studies have found similar omission of articles to MLU matched groups (e.g., Leonard et al., 1992a) others have reported significantly more omissions (e.g., Eadie et al., 2002; Rice & Wexler, 1996). Free tense morphemes (e.g., be and do) are complex as they carry agreement (e.g., number he is/they are) and the free non-tense articles also involve grammatical information as well as complex semantic, pragmatic grammatical information (e.g., number the book/those books) (O'Grady, 1997). For this reason, bound morphemes are the focus of the following comparison between tense and non-tense morphemes, as by only marking a single grammatical function, they allow a clear contrast.

Whilst a difficulty with tense markers is clear, the evidence around difficulties with nontense morphemes is more contentious. The first grammatical morpheme typically acquired is plural -s (e.g., Brown, 1973; de Villiers & de Villiers, 1972; Lahey et al., 1992). Children with DLD aged 4-5 years are commonly reported to mark plural -s with relatively high levels of accuracy (e.g., Oetting & Rice, 1993; Rice & Oetting, 1993; Rice & Wexler, 1996). However, percentage of use is lower for children with DLD (around 83-88%) than age and MLU matched groups (both approximately 97%). Similarly, other studies report groups with DLD performing less well than younger MLU matched groups on plural -s marking (Leonard et al., 1992a). Furthermore, its use in more complex contexts such as compound nouns, suggests some underlying challenges. When a group of children identified as G-SLI were asked to produce bare stems and plural stems in compound nouns, they failed to drop the regular plural -s (e.g., *rats-eater) (van der Lely & Christian, 2000), an error never observed in the typically developing group.

Another study investigated the use of several other non-tense morphemes including derivational suffixes (comparative *-er*, superlative *-est*) and the *-y* suffix added to nouns to form adjectives (e.g., *rock-rocky*). These morphemes are rarely omitted by the G-SLI group (Marshall & van der Lely, 2007) however, the authors did see some examples of including plural *-s* in the addition of *-y* (e.g., *rocksy*) which was never observed in the comparison group. Marshall & van der Lely (2007) argue that these types of errors indicate that plural nouns have not been analysed as morphologically complex, rather suggests that they have been learnt as single lexical items (or been 'lexicalised' – added as a whole word to the lexicon).

Bound morphemes have often been combined with free morphemes to make a tense vs non-tense composite measure for comparison (e.g., Bedore & Leonard, 1998; Bliss, 1989; Eadie et al., 2002; Rice & Wexler, 1996). Children with DLD consistently score higher on non-tense composites with tense morphemes more significantly impacted (e.g., Bliss, 1989; Eadie et al., 2002; Rice & Wexler, 1996). When individual analysis was been carried out, the omission of each of the tense morphemes (both bound and free) was found significantly higher in the group with DLD both in spontaneous and elicited speech samples (Rice & Wexler, 1996).

A further study with children with DLD (confirmed by a range of standardised general language assessments) compared performance on 1) a finite verb composite measure (-ed, -s, be, do), 2) a noun composite measure (possessive -s, plural -s and articles) and 3) MLU, to attempt to identify whether one could be used as a strong clinical marker for DLD (Bedore & Leonard, 1998). The verb composite showed a high sensitivity (over 85%) supporting tense morphology being a robust marker. However, the authors also pointed out that approximately 15% of children with DLD were not accurately identified, warning that the use of this marker alone would fail to identify these individuals.

By comparing tense and non-tense morphemes, it appears that children with DLD have more difficulty with those relating to tense. However, there may be some lesser difficulties with non-tense morphemes compared to typically developing peers. One possible compensatory strategy put forward is that children with DLD learn morphological forms as single lexical items rather than generating forms by applying their knowledge of morphology (Marshall & van der Lely, 2007). However, children with DLD do make errors of overregularisation suggesting that they are not only learning irregular and possibly regular verbs as single lexical items, but that they are able to generate novel tense forms eventually (e.g., Leonard et al.,1992a; van der Lely & Ullman, 2001).

4.4.2. Causes of morphological difficulties

Given the numerous factors associated with the morphological difficulties experienced by children with DLD, it is perhaps unsurprising that there are numerous accounts on the causes of these difficulties, based on linguistic, phonological and processing limitation factors.

Linguistic accounts centre around the difficulties experienced by children with DLD being specific to language and suggest the difficulties are a result of an underlying associated system e.g., a biological maturation (e.g., Wexler, 1994; Rice et al., 1995; Rice & Wexler, 1996) or computational system (e.g., Marshall & van der Lely, 2007; van der Lely, 1998; van der Lely & Ullman, 2001). Evidence that children with DLD produce errors typical of younger children (e.g., omission errors) and rarely atypical errors is argued to support these accounts. Children with DLD who experience

morphological difficulties are thought to remain in this earlier stage of language development typical of younger children.

Another number of theoretical accounts have focussed on the phonological form being associated with the morphological difficulties experienced by children with DLD. These accounts include the difficulties being associated with deficits in phonological segmentation (e.g., Joanisse & Seidenberg, 1998) or phonological processing (e.g., Chiat, 2001; Leonard, 1989). Phonological theories account for the specific difficulty with morphology being a result of difficulties detecting grammatical morphemes due to their lack of salience. One example supporting this argument for the difficulties with tense morphonology is the observation that temporal adverbs are acquired much more easily by children with DLD. Therefore, the difficulties are argued not to be due to the linguistic concept of tense specifically, rather the difficulties are due to the weak phonetic form of tense morphology.

Additional processing limitations have also been suggested to account, at least in part, for the difficulties for children with DLD (e.g., Montgomery & Evans, 2009; Plante & Gomez, 2018; Ullman & Pierpont, 2005). A deficit in the ability to detect regularities in the language has been theorised (Plante & Gomez, 2018; Ullman & Pierpont, 2005). This would result in children with DLD failing to recognise the pattens of the inflections resulting in the failure to acquire rules such as past tense *-ed*.

Difficulties with past tense have been the focus of a number of accounts, particularly focussing on the development of the regular and irregular past tense. The difference between the learning and use of these two forms and the associated overgeneralisation of the RSPT rule to irregular forms has been argued to demonstrate a dual processing mechanism for language learning. Given that the current study aims to improve the use of the RSPT, this literature is particularly relevant.

4.4.2.1. Dual vs single processing mechanisms

In English, there has been much research and debate around the morphology related to past tense (e.g., Past Tense Debate, Pinker & Ullman, 2002). Given that the current study aims to improve the use of the RSPT, this literature is particularly relevant. This debate has primarily focussed on whether multimorphemic words are stored by a single route processing mechanism (therefore learnt as single lexical items) or a dual

route processing mechanism (generated by adding grammatical morphemes to monomorphemic words). The dual route model suggests two separate mechanisms, the *lexicon* which is responsible for rote memory and *grammar* which is the rule-based system used to generate inflectional morphology as required (e.g., adding *-ed*, *-ing*, *-* s to verb roots each time) (e.g., Brown 1973; Pinker & Ullman, 2002). The lexical memory is where word and morpheme pairings are stored as whole/single units. The 'rule' or *grammar* system then combines the words and morphemes from the lexicon, into complex words and sentences simultaneously during the process of speaking. Whilst this question is not confined to tense and has been applied to noun related morphemes (e.g., plural -s (e.g., Marcus, 1995; Oetting & Rice, 1993)) and derivational morphemes (e.g., Clark. 2014), the use of the simple past tense has received the majority of attention with the comparison of irregular and regular forms. In fact, this regular-irregular distinction is the argument for Pinker's (1999) Words and Rules theory.

In contrast, single processing theories assume that regular verb and noun forms are stored very differently. Whilst in dual processing theory, minimal information is stored in the lexicon (e.g., verb roots and morphemes), in single processing theory a maximally rich lexicon is assumed with all verb infections stored separately (i.e., jump, jumping, jumps, jumped are all stored as separate lexical items just like nouns). Both theories propose that irregular verb and noun forms are stored as whole words in the lexicon. Here all words are stored with the relevant semantic and grammatical information (e.g., 'children' is stored with information about child and plurality).

Irregular forms are agreed to be learnt as single lexical items by single route processing theorists (e.g., Bybee & Moder, 1983) and dual route theorists (e.g., Pinker & Ullman, 2002). When a child wants to use an irregular past tense verb they first check if the required lexical item is stored, if so this is retrieved. Single route processing theorists argue that regular forms are stored and retrieved in the same way (e.g., Bybee & Moder, 1983). However, Pinker & Ullman (2002) argue that when a regular verb is required (according to the dual route processing theory), the lexicon is searched and if no stored past tense form is found, the regular past tense morpheme -ed is added to the verb stem. The Words and Rules theory acknowledges that regular

past tense forms may be stored in the lexicon but that they do not have to be (Pinker, 1999).

There is agreement in a U-shaped pattern of development of past tense forms (e.g., Brown, 1973; Blom, 2018). This pattern involves 1) irregular and regular verbs used first in their bare form, 2) irregular and regular forms of high frequency verbs are used, 3) errors of overregularisation occur, 4) correct forms are used and errors of overregularisation become rare. This does not happen simultaneously for all verbs, in fact each verb is thought to have its own U-shaped pattern of development (e.g., Brown, 1973; Blom, 2018).

In a single processing model, these overregularisation errors might be unexpected. These errors are unlikely to be found in the child's input and therefore could not be rote learnt. In fact, once an irregular verb is stored in the lexicon, what would cause the regular form of a different verb to disrupt this stored form? If the child is accessing stored items and not applying 'rules' and generating new forms, errors would presumably be more likely to be uninflected forms or errors accessing overlapping forms (e.g., come, coming and not *comed), but this is not the case.

Therefore, a dual processing mechanism may better account for these errors. As the child acquires the grammar, they apply this to regular and irregular verbs until each individual verb form becomes consistent. One of the arguments against dual processing mechanisms is that, once the child has acquired the 'rule' for a particular morpheme (in this case, past tense *-ed*), all regular verbs should be used relatively simultaneously. As discussed earlier in this chapter (4.3), this is not the case and there are a number of linguistic, phonological and processing factors impacting the use of past tense *-ed*.

The dual processing account therefore explains the errors of overregularisation well but fails to account for the U-shaped pattern of individual verb forms, rather than simultaneous acquisition of the regular past tense (Prasada & Pinker, 1993). Pinker (1999) states that some regular forms may be stored in the lexicon as single items (just as irregular verbs are), these are relatively few as minimal information is stored in the lexicon. It is therefore possible that initially children store correct forms of the

regular past tense (and irregular past tense) until they develop the grammar system argued to then generate these inflected forms.

4.4.2.2. The procedural deficit hypothesis

The declarative/procedural model (Ullman, 2001) is an extension of Pinker's "words and rules theory" (1999). It suggests that the procedural memory system is responsible for Pinker's grammar system, whilst in contrast the declarative memory system in responsible for the information stored in the lexicon. The procedural deficit hypothesis of language learning disorders (Ullman, 2004; Ullman & Pierpont, 2005) proceeds to account for the grammatical difficulties observed in children with DLD based on these dual model theories. The procedural deficit hypothesis suggests that the particular difficulties with grammar reflect a relatively intact declarative memory system (associated with explicit learning) contrasting with a relatively weak procedural memory system (associated with implicit learning) (Ullman & Pierpont, 2005). In this theory, it is a deficit in the procedural memory system responsible for implicitly learning the grammatical rules of the language that results in the difficulties with morphosyntax. In contrast, monomorphemic words are learnt explicitly and stored in a separate intact declarative memory system which accounts for the relative strength with irregular verbs for children with DLD. Furthermore, the frequency effects discussed earlier in this chapter (4.4) show evidence that children with DLD mark high frequency verbs more commonly. This evidence regarding the relative strength for children with DLD learning irregular verbs, supports the suggestions of a dissociation between the procedural and declarative memory systems.

The procedural memory system is suggested to refer to the brain system implicated in procedural (implicit) memory and it is related to the dorsal stream (see Ullman, 2004). It includes parts of the frontal/basal ganglia, with the pre-motor cortex and the cortex within Broca's area being of significant importance. Regions within these basal ganglia project to frontal regions that are suggested to subserve procedural memory. It is important to note that this is not the only function these areas perform, but they are particularly implicated in procedural memory. The procedural memory system is responsible for the control of motor and cognitive skills as well as learning new skills gradually, over a number of repetitions/exposures. This system is also commonly called the implicit memory system (Ullman & Pierpont, 2005). The learning of grammar

is therefore considered implicit, as it emerges over time once the child has been exposed to numerous repetitions of the patterns of the language and this learning occurs unconsciously. In contrast, the declarative (explicit) memory system is thought to relate to the ventral stream and involves regions of the medial temporal lobe (see Ullman & Pierpont for review 2005). In terms of language, the declarative memory system is thought to be responsible for storing word meanings (associated with the middle and inferior parts of the temporal lobe) and the phonological form (associated with the superior temporal and temporo-parietal regions). The superior temporal and temporo-parietal regions are suggested to integrate the procedural and declarative systems.

It is argued that the declarative memory system is responsible for storying the units of a language (e.g., words and grammatical morphemes) and the procedural memory system is responsible for combining these units into multimorphemic words (e.g., *crawl* + *ed* = *crawled*) and complex sentences. Whilst these two systems are considered separately in terms of the key role they play in language, there are a number of brain structures argued to play a role in both as might be expected. The procedural memory system is also linked to the structures that are involved in working memory and temporal processing (all associated with the dorsal stream).

Memory systems are therefore argued to account for the dissociation between relative strengths in vocabulary (thought to be learnt explicitly by the declarative system) and the difficulties with morphosyntax (thought to be learnt implicitly by the procedural memory system) in children with DLD. Overall, the evidence supports the dual processing mechanism to some extent, if regular and irregular verbs were learnt as single lexical items in the same way (in line with the single processing model), presumably there would be no overgeneralisation of the RSPT and no advantage to irregular verbs for children with DLD. Whereas, if a separate grammar processing mechanism existed to generate past tense forms of regular verbs at least initially, a weakness in this mechanism could account for the dissociation associated with DLD.

4.5. Assessment of tense development

The importance of selecting (or developing) assessment(s) that can accurately measure any gains in the use of the RSPT targeted in this intervention study was discussed in Chapter 3. The evidence from the development of the simple past tense and the difficulties experienced by children with DLD raise several further implications.

The method of comparing groups based on MLU is discussed in Chapter 3 and the associated problems are noted throughout the literature on children with DLD. This is highlighted by the fact that language samples from children with DLD compared with younger typically developing controls matched on MLU, have very different content (e.g., Johnston & Kamhi, 1984) and detailed analysis is required. Although these children resemble younger children in some ways (such as MLU), their profile of language is very different to that of typically developing children when analysed in detail (e.g., Leonard, 1989).

The use of structured tasks as well as more naturalistic tasks eliciting the required number of obligatory contexts should be used as outlined in Chapter 3. In addition, any assessment needs to take into account the linguistic, phonological and processing factors outlined in this chapter. The frequency of the verbs used in any assessment should be reviewed given the earlier acquisition of more frequently occurring verbs in the language (Matthews & Theakston, 2006; Oetting & Horohov, 1997) Assessment material that uses verbs that occur less frequently could result in assuming the child has no use of past tense forms (missing the child's use of high frequency past tense verbs). Alternatively, if only high frequency verbs were assessed the conclusion that tense was mastered may be drawn (when the child continued to omit tense on low frequency verbs in the language). Given the optional infinitive stage and tense morphemes initially being used inconsistently, assessment would need to include a high number of elicitations to accurately capture any inconsistent patterns. Additional support for a high number of elicitations comes from the obligatory context requirements. The majority of studies fail to take into account the phonological complexity and articulatory demands of regular past tense forms (e.g., Marshall, 2005). Thus, whilst a number of studies test the child's articulation of the past tense t and -d in monomorphemic words, they fail to do so in clusters. Therefore, the conclusions drawn in these studies, that the child has the articulatory skills to produce

regular past tense forms, is inaccurate as it takes no account of the complex clusters required (e.g., /pt/ in hopped, /ʃt/ in brushed, /kst/ in mixed). Similarly, the frequency that these clusters occur in the language needs to be considered along with the frequency of the verb.

The assessment of tense should also consider the complexity of the sentence being elicited. The child is most likely to use tense in simple sentences first which place fewer processing demands on the child (e.g., Grela & Leonard, 2000; Song et al., 2009). A range of tasks that elicit tense in the least demanding format (e.g., imitation) up to a higher demanding format (e.g., complex sentences) should be considered. Similarly, the evidence showing typically developing children are more likely to omit a morpheme (tense specific) in the middle of a sentence (e.g., Song et al., 2009) provides evidence that simple sentences should be used initially and complex sentences should be considered to analyse patterns of use as tense is mastered. It is also important to ensure that any tense marker mid-sentence can accurately be distinguished from continuous speech production during assessment to accurately determine any omission errors.

A number of studies have used composite measures of tense and agreement (e.g., Hadley & Short, 2005; Hilvert et al., 2020; Leonard et al., 2017; Rice et al.,1998) with some using up to 15 tense and agreement morphemes. These types of measures typically analyse natural speech samples and have been used to look at children's development of tense and agreement over time (Hadley & Short, 2005; Leonard et al., 2017) as well as comparing typical and language disordered groups (Rice et al., 1998). One criticism of composite measures that include a range of morphemes that mark tense, is that children receive a score for those tense markers that occur in high frequency and may have been learned as whole units rather than the accurate use of the bound morpheme (Hilvert et al., 2020). Whilst a composite measure involving a number of tense morphemes may prove a robust general measure over time, it is less suitable to measure changes in the use of a specific morpheme over a relatively short time; for example, measuring intervention of a particular morpheme (Hilvert et al., 2020). However, it does highlight the need to assess other, comparable tense morphemes when measuring intervention to measure generalisation.

4.6. Summary

Acquisition of the RSPT is a complex challenge for all children and is influenced by a number of factors. Language development in children with DLD has received attention in terms of what can be learnt about typical language development. Analysis of children's errors in typical development, as discussed comparing irregular and regular forms, has informed theories of language development and analysing populations who have difficulty with tense has further informed this understanding. The development of higher levels of language such as the use of complex sentences, is dependent on understanding and use of tense. Mastering tense is important because it is the steppingstone to more complex sentences which might otherwise not be achieved.

The RSPT is the only tense that does not require agreement and so is arguably easier to acquire, hence its acquisition as the first bound tense morpheme. For this reason, it was chosen as the target for this intervention study. In Chapter 5, the literature on what is known about the morphosyntactic difficulties experienced by individuals with DS is considered. The literature on the development of tense from typically developing children, children with DLD and individuals with DS is then used to inform the development of the intervention designed for the current study in Chapter 6.

5. The development of morphosyntax in individuals with Down syndrome

This chapter discusses the specific difficulties with morphosyntax experienced by individuals with DS as well as the potential reasons for these difficulties in relation to the profile associated with DS outlined in Chapter two. The language difficulties associated with DS have been likened to those associated with DLD (e.g., Laws & Bishop, 2003; 2004a; Eadie et al., 2002) and this chapter will compare and contrast the pattern of difficulties associated with DS to those with DLD.

5.1. Development of morphosyntax in English-speaking children with Down syndrome

Although historically the speech and language profile associated with DS was thought to be a result of general cognitive delay, it is now well established that this population experience specific difficulties with syntax and particularly morphosyntax compared to controls matched on any of the following: nonverbal mental age (e.g., Buckley, 1993; 1995; Laws & Gunn, 2004; Næss et al., 2015; Rosin et al., 1988), receptive vocabulary (Chapman et al., 1991; Fowler, 1990; Laws & Bishop, 2003; Laws & Gunn, 2004; Miller, 1988; Rosin et al., 1988) as well as expressive vocabulary to a lesser extent (e.g., Næss et al., 2011; Vicari et al., 2000b). Further, individuals with DS demonstrate more difficulties with grammar compared to others with intellectual disabilities (non-DS) matched on mental age (e.g., Chapman, 2006; Rosin et al., 1988) highlighting the particular difficulties with morphosyntax.

The difficulties with language comprehension are well reported in terms of group means on general language measures (e.g., Chapman et al., 1991; Laws & Bishop 2003). However, analysis at the group level has two drawbacks; firstly, the wide range of individual differences reported in this population (e.g., Fowler, 1990; Rondal, 1995) requires cautious comparisons of groups and secondly, the use of a general language comprehension measure reveals little of the specific difficulties being experienced with morphosyntax. These receptive assessments typically rely heavily on syntax, one such assessment being the Test for Reception of Grammar (TROG-2) (Bishop, 2003a). As a general receptive language measure, it does not include the range of grammatical morphemes and therefore provides no information regarding specific

areas of morphosyntax such as tense. A second common assessment reported in the literature is the Test for Auditory Comprehension of Language (TACL-R) (Carrow-Woolfolk, 1985). This assessment has a number of subtests and whist some specifically assess grammatical morphemes (including tense and non-tense on sentences, inflections) or focus elaborated others are related vocabulary. Therefore, the total score does not indicate specific difficulties with morphosyntax. Chapman et al. (1991) found a group of participants with DS performed significantly better on the subtest tapping vocabulary than the other two subtests. This important vocabulary strength may have been missed if a combined receptive score was calculated or alternatively may have inflated the general language score, disguising the specific difficulties with morphosyntax. Whilst this assessment better captures the comprehension difficulties with morphosyntax in general, it fails to highlight any specific difficulties with individual or groups of related morphemes (e.g., specific tense related morphemes). Therefore, the use of grammatical morphemes has been argued to be a better measure of the specific difficulties with morphosyntax in populations with disordered language (Rice & Wexler, 1996).

The use of grammatical morphemes by children and adults with DS has been elicited in spontaneous speech (e.g., Fowler et al., 1994), semi-structured conversation and play (e.g., Chapman et al., 1998), narrative tasks (e.g., Chapman et al., 1998), structured elicitation tasks (e.g., Ring & Clahsen, 2005), published assessments (e.g., Rice & Wexler, 2001) and captured by parental report measures (e.g., Miller et al., 1995; Rutter & Buckley, 1994). All methods of elicitation have found specific deficits in morphosyntax (e.g., Chapman et al., 1998; Eadie et al., 2002; Laws & Bishop, 2003; Rutter & Buckley 1994). Furthermore, the MLUs of individuals with DS are significantly lower than those individuals with other intellectual disabilities (e.g., Chapman, 2006; Rosin et al., 1988). These deficits most commonly include the frequent omission of grammatical morphemes (e.g., Bol & Kuiken, 1990; Chapman et al., 1998; Eadie et al., 2002; Laws & Bishop, 2003). This pattern of common omission errors with rare substitution errors (Eadie et al., 2002; Ring & Clahsen, 2005) is similar to the pattern observed in typical development.

Whilst there is clear evidence of the omission of grammatical morphemes associated with DS, there is little evidence charting the longitudinal acquisition of these

morphemes. One study looked at the acquisition of morphosyntax by children with DS (Rutter & Buckley, 1994). The authors charted the language development (vocabulary, word combinations and grammatical morpheme use) of 12 children with DS (aged 12-38 months at the start of the study) over approximately two and half years. The study used parent reported data and a morpheme had to be used accurately in a range of combinations to be counted as achieved (e.g., plural -s had to be used to mark a range of different objects as plural). The criterion of 90% use in obligatory context, often used as a measure of mastery (Brown, 1973), was not required. By the end of the study, a large number of the children (10 or more participants) had been reported using the following morphemes: present progressive -ing, preposition on, irregular past tense, possessive -s, articles a and the. There was a wide range of individual differences in age of acquisition of different morphemes. For example, plural -s was observed as young as 28 months and not observed at all in others at 38 months. Differences in order of appearance was also reported. For example, progressive *-ing*, the first morpheme to be acquired in typical development (e.g., Brown, 1973), was observed later than four other morphemes for one participant. These results should be interpreted with caution as indicators of order of acquisition as the usual acquisition criteria were not met. However, all 12 participants were observed to use a minimum of five of the grammatical morphemes identified by Brown (1973), which is an important observation, as it suggests that relatively young children with DS are able to use some grammatical morphemes appropriately.

A cross sectional study (Chapman et al., 1998) compared adolescents and young adults with DS to young typically developing children with similar MLUs. They observed that, at this much older age, their participants with DS were inconsistent in their use of bound grammatical morphemes in narratives, sometimes omitting morphemes that they used in other utterances. Given the evidence of early use (albeit inconsistent) of these morphemes (Rutter & Buckley, 1994), the fact that this use remains inconsistent suggests language is not following a typical pattern in individuals with DS. The older groups with DS continued to omit some of the earliest bound grammatical morphemes acquired, unlike the typically developing controls. More frequent omission of free morphemes is also reported for adolescents and young adults with DS (12-20 years) compared to much younger controls matched on MLU (Chapman et al., 1998).

Sentence repetition tasks also show this particular weakness in morphosyntax for those with DS compared to typically developing controls (e.g., Eadie et al., 2002) and to those with other intellectual disabilities (Marcell et al., 1995). Eadie et al. (2002), found that the typically developing control group performed significantly better than a group of 10 individuals with DS (mean 7;2 years) who performed similarly to a group of nine children with DLD (mean 5;3 years) (all matched on MLU). Whilst the authors concluded the results were partly as expected; the groups with DS and DLD performed worse on sentence imitation and the production of grammatical morphemes generally, there were some unpredicted results. The group with DS did not perform significantly differently to typically developing controls in a tense composite, although they were not significantly different to the group with DLD (who were significantly different to typically developing controls). Small sample size and individual differences could account for this finding as other outcomes conflict with previous studies. One example is that no significant difference on RSPT was found for the group with DLD which is considered a clinical marker of DLD (e.g., Archibald & Joanisse, 2009; Riches, 2012). Therefore, the question of whether tense related morphemes are a particular challenge for individuals with DS is raised.

5.1.1. Tense

Given the relative strength in receptive vocabulary observed in individuals with DS, it might be predicted that irregular tense forms would be a particular strength. As discussed in Chapter 4, irregular forms are believed to be learnt as single lexical items like nouns (e.g., Bybee & Slobin, 1982), which would potentially make them easier to acquire for those with relative receptive vocabulary strengths. The evidence to support this is mixed. Eadie et al. (2002) found that a relatively strong performance on irregular verbs (both irregular past tense and irregular third person present tense *has/does*), was responsible for their group with DS not performing significantly differently from the typically developing controls matched on MLU. The performance of the children with DS (mean age 7;2 years) was significantly worse for regular past tense supporting this suggestion. Similarly, Laws and Bishop (2003) reported a group of adolescents with DS performed similarly on irregular verbs to controls matched on mental age, but their use of regular past tense was worse. Conversely, Ring and Clahsen, (2005) found irregular and regular verbs were equally challenging for a group of eight children with DS (12-14 years) on an elicitation task. The group produced high numbers of omission

errors on both the regular (80.5% omission errors) and irregular verbs (75.5% omission errors).

Whilst the evidence on irregular vs regular past tense verbs is mixed, there is clear agreement that individuals with DS omit both bound and free tense related morphemes more than mental age matched controls (Chapman et al., 1998; Laws & Bishop, 2003; Ring & Clahsen, 2005) and those matched on MLU (Eadie et al., 2002; O'Neil & Henry, 2002). The evidence is more mixed in terms of non-tense morphemes. One study compared non-tense morphemes to tense morphemes in three individuals with DS and reported more difficulty with the morphemes related to tense (O'Neil & Henry, 2002). However, other studies have shown the use of non-tense morphemes to be omitted more frequently compared to controls matched on mental age, including plural -s (e.g., Chapman et al., 1998; Ring & Clahsen, 2005), progressive -ing and possessive -s (Chapman et al., 1998; Fowler et al., 1994). Laws & Bishop (2004a) have criticised some of these findings, arguing that the MLUs of individuals with DS included in the studies were too low to expect the use of many of these morphemes.

Evidence from an elicitation task investigating regular and irregular plurals and comparative adjective *-er*, in addition to regular and irregular past tense, found individuals with DS performed significantly worse than typically developing controls (Ring & Clahsen, 2005). Ring and Clahsen (2005) also report lower percentages of unmarked forms for non-tense morphemes (e.g., unmarked regular plurals 16.6% vs unmarked RSPT 80.5%). Whilst it appears individuals with DS experience difficulties with a range of tense and non-tense morphemes, the extent of these difficulties remains unclear with the possibility that difficulties are more severe for tense morphemes. More research is needed as there are relatively few studies detailing the difficulty that individuals with DS experience with morphosyntax and those few studies involve relatively small samples with wide age ranges. However, the evidence suggests that whilst morphosyntax in general may be problematic, perhaps some morphemes are particularly challenging, such as those that mark tense.

5.2. Factors associated with Down syndrome that impact morphosyntactic development

Whilst it is clear that children and adults with DS experience significant difficulties with morphosyntax, the reason for these difficulties is complex. There are numerous linguistic, phonological and processing factors associated with DS that have the potential to impact the acquisition of grammatical morphemes. These factors discussed in Chapter 4 (4.3.1-4.3.3) specifically related to the RSPT, are considered in terms of the profile associated with DS outlined in Chapter 2.

5.2.1. Intellectual impairment

One potential reason for the difficulties with the development of morphosyntax experienced by individuals with DS is the associated intellectual impairment. Considering the maturation and optional infinitive accounts, do many individuals with DS never reach an intellectual level which corresponds to the successful acquisition of grammatical morphemes? Whilst some researchers take this view, there is considerable evidence and agreement in the literature to support an alternative view that morphosyntactic difficulties experienced by individuals with DS are not simply due to intellectual impairment (see Stojanovik, 2014 for a review). If intellectual impairment was solely responsible, the vocabulary and language levels of individuals with DS would be in line with nonverbal mental age and this is not the case (e.g., Abbeduto et al., 2007; Næss et al., 2011). The uneven language profile with relative strengths in receptive vocabulary, often in line with nonverbal mental age, argues against cognition being solely responsible (Chapman et al., 1991; Mason-Apps et al., 2020). In addition, the similarities between the specific morphosyntactic difficulties observed in children with DLD who do not experience cognitive delays and individuals with DS further argue against this (e.g., Laws & Bishop, 2003; 2004a). Individuals with DS experience difficulties with morphosyntax that exceed (and therefore cannot be explained by) any cognitive delay, showing a similar profile to children with DLD who experience significant difficulties with morphosyntax compared to their cognitive ability. Furthermore, perhaps the most persuasive evidence comes from morphosyntactic comparisons with individuals with similar cognitive delays (non-DS) who do not experience the same specific difficulty with morphosyntax (Chapman, 2006; Marcell et al., 1995). These studies demonstrated that there must be some additional factor (rather than cognition alone) that leads to the morphosyntactic difficulties experienced by individuals with DS such as hearing, phonological short-term memory, articulation and/or inaccurate phonological representations.

5.2.2. Hearing

Given the hearing difficulties associated with DS, it may be expected that this would impact the development of morphosyntax. Recurring ear infections and OME continue for 38% of children with DS up to at least 8 years (Barr et al., 2011) and mild-moderate hearing loss continues to occur for approximately 60% of adolescents and young adults with DS (Chapman et al., 2000). The reduced salience of grammatical morphemes that is thought to impact acquisition for all children (Whan Cho & O'Grady, 1997) would be further reduced for those with hearing difficulties. Hearing impairment or history of hearing impairment has been found to be a predictor of persistent speech sound disorder (Wren et al., 2016).

Historically the literature on the links with hearing and expressive language in children with DS have been mixed with some early evidence of this link (e.g., Whiteman et al., 1986) whilst no correlation is reported by others (e.g., Chapman, et al., 1998). Although Chapman et al. (1998) specifically investigated the deficits of bound and free morphemes, hearing screening was only carried out on the day of speech sample elicitation and no information was reported on past hearing ability. Therefore, no consideration of history of hearing loss was taken into account which is common in the literature. In addition, studies often report excluding children with DS if they have hearing difficulties. Given the prevalence of hearing difficulties associated with DS, such samples seem unrepresentative. Inadequate measures to test fluctuating hearing loss could explain the lack of correlation between hearing levels and language development in children with DS in previous studies (Laws & Hall, 2014), particularly in light of the fact that children with DS are often underdiagnosed and undertreated for chronic ear infection (Roizen et al., 1994). In a later study, Chapman and colleagues (2000), found hearing loss accounted for 7% of the variance in their study looking at predictors of MLU in an expressive narrative task. Laws and Hall (2014) used parent report and collected historic audiological records for 41 children with DS to investigate this relationship. They found that an early history of hearing loss for children aged from 2 to 4 years, often including fluctuating hearing loss, had a significant impact on later speech and language development when chronological age and non-verbal mental age were accounted for.

5.2.3. Memory

Phonological short-term memory has been identified as a deficit in DS (e.g., Fowler et al., 1995; Hulme & Mackenzie, 1992; Jarrold & Baddeley, 1997; Kay-Raining Bird & Chapman, 1994) and it is argued to be important for language learning (e.g., Gathercole & Baddeley, 1993) and specifically for the acquisition of grammar (e.g., Baddeley et al., 1998). Whilst the relationship between receptive vocabulary and phonological memory has been questioned when using digit span (e.g., Hulme & Mackenzie, 1992; Jarrold & Baddeley, 1997), the link between phonological memory and nonword repetition has some support (Laws 1998; Laws & Gunn, 2004). In a longitudinal study of individuals with DS (10-24 years), Laws and Gunn (2004) found earlier phonological memory predicted receptive vocabulary and grammar comprehension. Laws and Bishop (2002) argue that those with DS have co-occurring phonological memory and auditory processing deficits which is therefore likely to be at least in part responsible for the difficulties with morphosyntax.

Considering the specific difficulties with phonological short-term memory (Jarrold et al., 2002; Jarrold et al., 2009; Miolo et al., 2005; Seung & Chapman, 2000) and the vulnerability of grammatical morphemes due to their lack of salience (Whan Cho & O'Grady, 1997), it is possible that individuals with DS may fail to retain and/or store accurate phonological representations in the impaired phonological input store. For example, when the child hears an utterance like the boy jumped over the fence, they are required to hear and maintain the utterance in the phonological input store (maintained by the phonological loop) to extract the regular past tense rule. Given the hearing and verbal short-term memory difficulties associated with DS, it is possible that these individuals may not maintain these vulnerable grammatical morphemes, increasing the challenge of identifying these morphosyntactic patterns/rules. Thus, these degraded and inaccurate phonological representations may theoretically result in lexical representations that omit the grammatical morphemes (e.g., jumped may be stored in the lexicon as an incomplete phonological representation such as jump /dʒʌmp/ or even /ʌmp/). Evidence to support this hypothesis comes from studies that

individuals with DS are poor at learning accurate phonological forms generally (e.g., Jarrold et al., 2009).

Furthermore, given that these morphemes are less well established in these individuals, difficulties with phonological processing are predicted to place these unstressed and unfamiliar parts of language more at risk. Therefore, processing limitations have been suggested to account for the divergence between syntactic and lexical comprehension (Chapman et al., 1998).

These phonological short-term memory difficulties could be responsible for the possible difficulties with implicit memory reported for individuals with DS (e.g., Bussy et al., 2011). If children with DS are unable to hear and retain syntactic structures, they would potentially be unable to implicitly extract the patterns of morphosyntax (Rondal, 2017).

5.2.4. Speech

The difficulties with articulation and phonological processes potentially further impact the production of morphosyntax. Final consonant deletion is reported to be common in children with DS (Dodd, 1976; Stoel-Gammon, 1980). As many grammatical morphemes appear at the end of a word these are likely to be particularly at risk of omission. In addition, fricatives are reported to be particularly problematic and -s (pronounced as /s/ or /z/) is used to mark plurality, possession and third person singular. Regular past tense is marked by stops (/t/, /d/) which are less problematic although frequently the addition of the RSPT stop, results in a cluster (e.g., jumped /dʒʌmpt/, crawled /krɔːld/) which is particularly problematic for children with DS (Dodd, 1976; Stoel-Gammon, 1980). These phonological and articulation errors are persistent over time (e.g., Burgoyne et al., 2012a) and into adulthood (Van Borsal, 1988; 1996) and this raises the question as to whether individuals with DS are simply unable to articulate some grammatical morphemes. The ability to produce consonant clusters has been found to significantly account for the production of grammatical morphemes (particularly for the regular past tense) in preschool children with phonological impairment (Howland et al., 2019). So, is it potentially the phonological difficulties experienced by individuals with DS that are partly responsible for the omission of grammatical morphemes?

This explanation appears too limited, as children with DS are reported to make fewer errors in imitation (Dodd, 1976) suggesting that some children at least, are able to produce sounds and sound combinations required by morphosyntax. This suggests that at least some individuals with DS may be able to execute the forms needed to mark morphosyntax. This is further supported by the inconsistent pattern of morphosyntax, as it is clear these morphemes are produced at times (Chapman et al., 1998; Rutter & Buckley, 1994). Furthermore, intervention focussing on speech production suggests improvements can be made, even with children as young as 3-5 years of age (Dodd & Leahy, 1989; Cholmain 1994; van Bysterveldt et al., 2009).

5.2.5. General morphosyntactic deficit

Given the difficulties with verbs particularly, individuals with DS may not reach a language level to support morphosyntax. It is suggested that verb acquisition involves making the connection between lexical information and syntax and morphosyntax (see Hesketh & Chapman, 1998), therefore successful verb acquisition involves learning the syntactic frame or a schema of the event. For example, the action lifting involves an object to be lifted, a person to do the lifting and the action itself. This information needs to be extracted to be able to use the verb in an appropriate phrase (e.g., Mummy lifted the lid). In this way, verb learning is particularly more dependent on verbal shortterm memory as the child must hold the syntactic frame to extract these associations. The difficulty with holding this information in verbal short-term memory is highlighted by the difficulties with sentence repetition tasks; adolescents and young adults with DS show even more difficulty compared to individuals with intellectual disabilities (non-DS) when utterances exceed two words (Marcell et al., 1995). Loveall et al. (2019) suggest that the reason individuals with DS use fewer verbs, despite having access to a diverse range of verbs, reflects the fact that it is the syntactic frame associated with verbs that is problematic. In fact, the authors state that verbs "play a key foundation" role in syntax. If disrupted, then syntactic development could be impacted" (Loveall et al., 2019. p83). Therefore, it may be a specific impairment with verbs that is responsible for many of the morphosyntactic difficulties experienced by individuals with DS. If verbs are omitted, then the grammatical morphemes associated with verbs (tense) will certainly be omitted. This difficulty with verbs may reflect the verbal shortterm memory difficulties discussed earlier. If individuals with DS have difficulty storing

and maintaining the utterance to extract the syntactic frame, then this could explain why verbs and associated morphosyntax are a particular challenge.

5.3. Comparing the morphosyntactic difficulties in Down syndrome to those with Developmental language disorder

Given the similarities in the significant difficulties with morphosyntax, individuals with DS have been compared to those with DLD (e.g., Laws & Bishop, 2003; Laws & Bishop, 2004a; Polišenská & Kapalková, 2014; Rice et al., 2005; Ypsilanti & Grouios, 2008) as these difficulties with morphosyntax cannot be explained by non-verbal abilities for these populations. In comparison to individuals with DS, individuals with DLD do not experience the intellectual impairments or hearing difficulties associated with DS. Despite their cognitive ability and unimpaired access to the language around them, they often have difficulty with vocabulary, phonology and pragmatics but it is morphosyntax that is most significantly impaired in these individuals (e.g., Leonard, 2014). Both groups demonstrate a relative receptive vocabulary strength, expressive language is impaired and lags behind receptive language and both groups have significant difficulties with word and nonword repetition tasks (Laws & Bishop, 2003a). Furthermore, both groups are reported to have difficulties with phonological short-term memory and potentially associated difficulties with implicit learning.

In experimental studies, these groups have been compared based on nonverbal mental age (Laws & Bishop, 2003), MLU (Eadie et al., 2002) and on receptive and expressive vocabulary (e.g., Polišenská & Kapalková, 2014). When errors in tense marking occur, they are almost always errors of omission for both groups (e.g., Laws & Bishop, 2003a; Rice et al., 1995; Rice & Wexler, 1996), however individuals with DS omit the whole verb (rather than just the morpheme) significantly more frequently than individuals with DLD during elicitation tasks (Laws & Bishop, 2003).

5.3.1. Tense

Tense marking has been found to be challenging for both individuals with DS and for those with DLD when compared to controls (e.g., Eadie et al., 2002; Laws & Bishop, 2003a). However, one study reported that free tense morphemes were not significantly

impaired (including auxiliary *be*, copular *be*, third person irregular *does/has*) in individuals with DS compared to a typically developing group matched on MLU (in contrast, those with DLD were significantly worse on third person irregular). However, both groups performed significantly worse on a bound tense morpheme composite than a younger typically developing group (Eadie et al., 2002). Furthermore, when the use of the individual morphemes within the composite was analysed, they found the group with DS scored significantly worse on the use of RSPT than the typically developing controls, but that the group with DLD did not (both groups scored significantly lower than controls on third person singular *-s*). This result is surprising as evidence suggests RSPT is a specific difficulty for individuals with DLD (e.g., Rice et al., 2000).

Laws & Bishop (2003b) specifically compared the use of tense in individuals with DS and DLD to a typically developing group all matched on nonverbal mental age (DS=19 participants 10-19 years, DLD=17 participants 4-7 years, TD=18 participants 4-7 years). The authors found that both the DS and DLD group were significantly impaired on the use of third person singular -s and RSPT -ed.

In terms of non-tense morphemes, both groups have been found to score significantly lower on non-tense morpheme composites than MLU matched controls and not different from each other (Eadie et al., 2002). Whilst tense marking has become a hallmark for DLD, difficulties with non-tense morphemes are commonly reported, including lower percentage use of the bound plural -s morpheme compared to MLU matched controls (e.g., Leonard et al., 1992a; Rice & Wexler 1996). This pattern is also reported in the literature regarding the use of the early non-tense grammatical morphemes by individuals with DS (e.g., Chapman et al., 1998).

Whilst individuals with DS and DLD have been found to have particular difficulty with the use of the RSPT in elicitation tasks (e.g., Eadie et al., 2002; Laws & Bishop 2003b), the use of irregular forms may be a relative strength. Individuals with DS have been reported to score similarly to typically developing controls in irregular past tense forms (e.g., Eadie et al., 2002; Laws & Bishop 2003b). Laws and Bishop (2003b) reported their group of individuals with DLD scored significantly lower on irregular verbs which is surprising given that irregular verbs have been reported as a relative strength for individuals with DLD in other studies (e.g., Rice et al., 2000; Rice et al., 2002; van der

Lely & Ullman, 2001). The conflicting findings of the Laws and Bishop study (2003b) should be interpreted with caution due to small sample size and the group with DS were not significantly different to the group with DLD on their use of irregular verbs.

Given that irregular verbs are thought to be learnt as single lexical items, the relative receptive vocabulary strength in DS and DLD could potentially support irregular verbs as a relative strength compared to regular past tense marking. The ages of the individuals with DS in comparison studies are generally considerably older than those with DLD and the matched controls. This potentially provides an advantage in the number of years exposed to the language and opportunity to develop wider vocabularies.

5.3.2. Potential factors

Hearing impairments could potentially account for some of the challenges for individuals with DS as a correlation between hearing and past tense morphemes (regular and irregular) for those with DS has been reported (Laws & Bishop, 2003). The phonologically weak properties of morphosyntax would make the implicit learning of grammar challenging as these morphemes would potentially be lost from the input for children with DS. However, the same authors report no correlation between hearing impairment and DLD which refutes the role of hearing loss as an underlying factor for both groups.

One factor associated with DS and DLD is phonological short-term memory difficulties (e.g., Bishop et al., 1996; Jarrold et al., 2000; Laws & Bishop, 2003). Laws and Bishop (2003) compared their groups of individuals with DS, DLD and TD matched on mental age and found both groups with DS and DLD were significantly impaired, compared to controls, on word and nonword repetition and this difficulty increased for both groups as syllable length increased. The evidence that both groups experience phonological short-term memory difficulties supports this as a likely potential factor underlying the difficulties with morphosyntax. If the child is unable to retain utterances with intact morphosyntax, they would potentially be unable to implicitly extract the patterns and rules associated with grammar.

Speech difficulties are a common factor, with children with DLD also experiencing difficulties with phonology (e.g., Leonard, 2014) and articulation of clusters (e.g.,

Gallon et al., 2007; Leonard et al., 1988). Increasing cluster length has been found to lead to increased omission of the regular past tense in individuals with DLD and future research should consider exploring this factor in relation to individuals with DS. However, although this is a potentially contributing factor, it seems unlikely to be largely responsible, given the difficulties with receptive grammar.

A more potentially crippling factor is the particular challenge with verbs for individuals with DS (Grela, 2002; Hesketh & Chapman, 1998; Loveall et al., 2019) and for those with DLD (see Kan & Windsor, 2010). Children with DLD have also been shown to have a limited range of verbs (Watkins et al., 1993) as well as omitting and substituting them (Chiat, 2000; Rice & Bode, 1993) and the evidence documenting the deficit in verb use by individuals with DS is considerable. The difficulties with the acquisition of verbs and morphosyntax has been suggested to be a result of difficulties with phonological short-term memory. Therefore, it may be an underlying deficit in syntax, which is reliant of phonological short-term memory that is largely responsible for these difficulties.

This evidence supports a number of common factors observed in individuals with DS and DLD that are likely to contribute to the challenges in the acquisition of morphosyntax faced by these groups. Additional research comparing these two groups is clearly needed as studies are few and findings are mixed. Any successful intervention that focusses on morphosyntax for individuals with DS, taking into account factors including those associated with DLD, also have the potential to be advantageous to individuals with DLD.

5.4. Summary and rationale for the study

Individuals with DS experience significant difficulties with morphosyntax and there are clear similarities between the speech and language profiles associated with individuals with DS and those with DLD. Furthermore, these difficulties cannot be explained by non-verbal abilities for either of these populations. For individuals with DS, the hearing and phonological short-term memory difficulties are suggested to seriously disrupt the development of syntax and morphosyntax (e.g., Rondal, 2017). The relative visual short-term memory strengths provide a potential alternative learning route to that

reliant on hearing and phonological short-term memory. Rather than relying on these deficits to implicitly learn grammatical rules, it is hypothesised that explicitly learning these rules may have potential benefits.

As discussed in Chapter 2 (2.3.5), individuals with DS are reported to have whole word reading strengths. There are clear parallels between the whole word reading strengths and the receptive vocabulary strengths observed in individuals with DS and receptive vocabulary has been shown to predict reading (Laws & Gunn, 2002) and spelling (Lim et al., 2014) in individuals with DS. In contrast children with DS are reported to have difficulties with phonological awareness skills including segmenting sounds, particularly final sounds (e.g., Fletcher & Buckley, 2002; Snowling et al., 2002). Nevertheless, some studies (e.g., van Bysterveldt et al., 2007) have reported significant gains in phonological awareness skills (e.g., initial phoneme identity) following an intervention using print. There is also evidence to suggest that learning novel words using visual (e.g., orthography) and verbal (e.g., modelling) techniques is relatively easier for these individuals than learning novel words with just the verbal input (e.g., Mengoni et al., 2013). Furthermore, it has been suggested that a reciprocal relationship between reading and phonological awareness exists for typically developing children (e.g., Gathercole & Baddeley, 1993; Perfetti et al., 1987).

This evidence supports the use of the written form when targeting the spoken form and this strategy has been used in successful interventions targeting morphosyntax (Buckley, 1993), vocabulary (Mengoni et al., 2013) and speech (van Bysterveldt et al., 2009) in individuals with DS. Therefore, explicitly teaching a grammatical rule using explicit methods, that include orthographic support, to develop awareness and understanding of the associated morpheme(s) could potentially be beneficial. Implicit methods, such as modelling in ideal listening conditions, could also be effective, providing better opportunities for children with DS to hear many examples of the rule being used in a natural context. Therefore, teaching a grammatical rule to individuals with DS, using combined implicit and explicit methods could potentially be beneficial, as has been reported for children with DLD (e.g., Calder et al., 2021), Such an intervention could provide implicit and explicit strategies that strengthen the phonological forms and meaning of a grammatical morpheme to develop the child's

understanding and use of the associated rule. These predictions led to the following research questions (see below):

5.5. Research questions

- 1. How effective is an intervention that teaches the use of the RSPT forms, using implicit and explicit techniques, for children with DS?
- 2. If such an intervention can be shown to be successful, will learning generalise, and, in particular, will children demonstrate errors of overregularisation after the intervention?

6. The development of the PaTI intervention

To answer the research questions, an intervention that targets the RSPT using explicit and implicit methods was developed. The intervention was specifically designed for children with DS and therefore was required to consider the speech, language and cognitive profile associated with DS. It has been suggested that no universal speech and language intervention programme can be suitable for all children with DS given there is no single pattern of speech and language skills (Kumin, 2008). However, there have been a number of successful interventions evaluated with children and young adults with DS, suggesting this population could be supported by appropriate, effective intervention. A recent meta-analysis of language interventions for this population (Smith et al., 2020) concluded that children with DS can benefit from receiving targeted language intervention including intervention that focusses on grammar, although studies are few with a high risk of bias. The importance of communication on social functioning (e.g., Dura, 1997; Storey & Provost, 1996) and participation in the work environment (e.g., Holmes, 2003) make language intervention a priority area for this population. The research on language intervention for children with DS is discussed below together with any implications for future intervention studies.

6.1. Factors associated with previous language interventions for individuals with Down syndrome

As discussed in Chapters 2 and 5, children with DS are reported to have poorly specified phonological representations of words (Jarrold et al., 2009). It is argued that phonological short-term memory is required to retain a novel word in order to form a long-term stable and accurate phonological representation (e.g., Baddeley et al., 1998). Children with DS have deficits in phonological short-term memory (e.g., Jarrold et al., 2000) and in addition have a high incidence of hearing loss (e.g., Laws & Hall, 2014). Hearing loss may impact on the accuracy of the initial input received by the phonological short-term memory and subsequent difficulties with retaining this representation will impact the long-term phonological representation stored. Studies on fast mapping in children with DS provide evidence of these difficulties accurately acquiring the phonological form of a word (e.g., Chapman et al., 1990). Whilst many studies have typically involved nouns, it is reasonable to assume that the same

difficulties would impact the acquisition of words from other syntactic categories including verbs. In addition, verbs are reported to increase the demands on phonological memory as more complex syntactic frames are required to be retained to extract meaning. This is also true for morphosyntax and it has been suggested that the deficits in phonological short-term memory are responsible for the difficulties with morphosyntax in children with DS (e.g., Rondal, 2017). The intervention research regarding children with language difficulties (with a focus on children with DS) has therefore been reviewed to identify explicit and implicit strategies that may support the development of language, including the development of morphosyntax although studies on that aspect are limited.

6.1.1. Modelling and imitation

One common intervention technique for supporting language acquisition for adolescents and children with DS is adult modelling of the target both in direct intervention (Buckley, 1993; Sepúlveda et al., 2013) and in more naturalistic intervention (e.g., Girolametto et al., 1998). Receiving an accurate model of the phonological form is essential for acquiring accurate phonological representations and the hearing difficulties and phonological short-term memory deficits associated with DS result in these accurate models not always being received and/or maintained. Modelling has been used in successful intervention targeting vocabulary (e.g., Yoder et al., 2014) and expressive grammar (e.g., Buckley, 2003; Sepúlveda et al., 2013). Similarly, the use of recasts alone (modelling following an error) has been reported to have had some success in extending the language used by children with DS aged 4;3-7;4 years as shown by increasing MLU (Camarata et al., 2006).

Modelling plays a role in almost all interventions and several studies have included modelling as well as a number of other strategies. For example, in the intervention examples provided by Sepúlveda et al. (2013), 20 Spanish speaking children with DS (aged 6-14 years) were asked to generate a sentence for a picture. If they found this challenging, the adult provided the beginning of the sentence to provide context before finally moving to modelling and requesting imitation if the child was unsuccessful.

A study comparing parent introduction of new words to younger (30-month-old) children with DS, children with autism and typically developing children (aged

18months), found that increased frequency of parent modelling resulted in increasing the likelihood of the child attempting to produce the modelled word (Adamson et al., 2015). In this study, novel words were introduced by parents in play contexts as the name for a new object and the sound it made. Furthermore, parents requesting the child imitated the word, increased the child's attempts to imitate for all groups with the largest benefits for those with DS. The researchers only coded the child's expressive response following the adult's production of a novel target, so any later child attempts to use the novel word were not recorded. Nonetheless, modelling seems to be an effective technique for all children and adding requests for imitation may be a particularly useful technique for children with DS.

6.1.2. Frequency of modelling in context

Given the difficulties children with DS experience with fast mapping, the question is raised regarding how many repetitions of representations are required. The vocabulary and language delays experienced by children with DS suggest increasing the number of exposures to a word as a possible technique for targeted intervention. In the early years the amount of 'linguistic mapping' opportunities provided by parents to children with DS at 6 months has been found to predict the number of spoken words at 9 months (Yoder et al., 2014). Several successful intervention studies for children with DS, involve multiple repetitions of the target, including at the vocabulary (Burgoyne et al., 2012a), grammatical morpheme (Sepúlveda et al., 2013) and sentence (Buckley, 1993) level. These studies have also raised the importance of using the targets in multiple contexts. The study by Burgoyne et al. (2012a), included 'introducing a new word' for five minutes as part of the daily intervention. This consisted of the teaching assistant (TA) modelling the word, asking the child to repeat the word, showing a number of different picture representations of the word, relating the word to the pupil's own experience, presenting a definition card and creating a word web. This was followed by a further 15 minutes reinforcing the meaning of the new word, using it in connected speech and finally using it in written language. Therefore, the children were given a high number of models of the new word in different contexts as well as frequently asking the child to produce the new word and then asking them to write it. In this way, the child's representation of the word in the lexicon (phonological, semantic and orthographic) and the links between them would be strengthened. This intervention led to significant gains for the intervention group over the waiting control

group on their bespoke measure of taught vocabulary, suggesting the success of this frequency of modelling.

The addition of context seems to be an important aspect of intervention, as demonstrated above in the Burgoyne et al. study (2012a). Several of the intervention studies supporting multiple repetitions included the provision of context, in some form, to support understanding and/or production. For example, in the Sepúlveda et al. study (2013), preceding sentences/lead in sentences were provided, giving information relating to the grammatical morpheme targeted (e.g., plural -s, "here we have lots of..."). They also provided the contrast (e.g., "here is one...") which would provide more information for the child. Context has been provided in terms of the real world for children with DS including reviewing videos of the participant themselves to target personal narratives (Finestack et al., 2017). Other studies have provided more abstract context for example, creating the backdrop of an alien planet to introduce novel words (Mengoni et al., 2014).

Therefore, it is hypothesised that children with DS would benefit from more repetitions in context to potentially support the development of morphosyntax in the same way.

6.1.3. Use of ideal listening conditions

Whilst listening conditions are not regularly reported as part of the intervention, it is hypothesised that studies carried out in experimental conditions (e.g., Adamson et al., 2015; Chapman et al., 1990; Mengoni et al., 2013) and those where participants attended a session delivered by an external professional(s) (e.g., Buckley, 1993; van Bysterveldt, 2006; 2009; Yoder et al., 2014) are likely to have occurred in relatively quiet listening conditions. Following the Burgoyne et al. study (2012a) a teacher's handbook was produced that specified 'the intervention sessions should be delivered somewhere quiet and free from distraction' (A Reading and Language Intervention for children with DS, 2012b). Although not prioritised in the studies, this may be an important component for children with DS who are likely to have difficulties with hearing and phonological short-term memory. Therefore, any assessment and intervention should consider the importance of providing more ideal listening conditions.

6.1.4. Use of orthography

Given the relative strength in visual short-term memory, the use of orthography has been suggested and investigated as an intervention method for children with DS. Buckley (1993) compared two intervention strategies targeting expressive language with teenagers with DS. Following assessment of receptive language using the TROG (Bishop, 1983), six target language constructions were chosen: personal/plural pronouns, prepositions, comparatives, passives, subjects with postmodification and "X but not Y". The twelve teenagers were divided into six matched pairs. For each target construction, one group received intervention using pictures with matching written sentences (the "orthography present" condition) and the other received intervention using pictures only ("orthography absent" condition). For each new target construction, the method alternated so the other group received the orthography present condition. For both conditions, the teenagers were presented with 12 examples and asked to imitate the adult model twice before being asked to 'spontaneously' produce the sentence. In the final assessment, pictures were presented without text and the teenager was asked to spontaneously produce a sentence. Significant gains were found for the *orthography present* condition for three out of the six structures: comparatives, pronouns and subjects with postmodification. No gains were found for the *orthography absent* condition.

It has been suggested that text may support learning, comprehension and memory of spoken vocabulary and language (Buckley, 1993; 1995; Burgoyne et al., 2014; Mengoni et al., 2013). Presenting individuals with DS with the visual form, potentially provides a less transient and more salient representation that could remediate some of the demands on hearing, phonological short-term memory and phonological awareness that are areas of specific difficulty. Buckley (1993) concluded that reading helped when practising repeating these longer, more complex and grammatically correct sentence structures and this practice led to the gains. Only seven out of the 12 participants had reading levels sufficient to be scored on the Neale Analysis of Reading (Neale, 1966) and four of the seven scored a reading age of less than 4;7 years. Therefore, the reading level for many of the participants was low. Authors reported that the two participants who showed the greatest gains in the *orthography present* condition had very limited reading at the beginning of the study. Therefore, it is unlikely that many of the participants were able to fully read the sentence support

provided. For poor/non-readers, the print is unlikely to be providing support for acquiring accurate phonological representations unless the intervention is teaching the participants to read and linking the written and phonological form of the word. Nor is it likely to visually support the memory of longer more complex structures as the poor/non-readers would not have been able to make use of this information. Perhaps the print provided a clue for the participants as to the number of spoken words which reminded and encouraged them to use more words. Reading level following the intervention may have provided some insight into the role of print for the participants but this was not reported. However, the use of print certainly enabled the participants to practise saying the target sentence structures, which in turn led to them being able to use these sentences when describing pictures, without a model or request to imitate.

Other researchers have argued that print can be used as an intervention technique with children with DS, as they may find it easier to learn new vocabulary when the graphemes (written letters) are present (e.g., Mengoni et al., 2013). These authors reported that their participants (17 children with DS aged 7-16 years) benefitted from the orthographic cue when learning consonant-vowel-consonant (CVC) non-words compared to non-orthographic print (Cyrillic and Greek). The group with DS performed equally well as a younger typically developing control group matched on reading ability. They chose phonemes that were typically acquired by four years of age, in an attempt to limit the impact of articulation difficulties that commonly occur with sounds later to acquire. It is important to note that the intervention did not only present the word but included repetition of the word, and some additional focus on the internal structure of the word including phonological awareness (e.g., sounding it out and identifying the individual sounds in the words). This practice is also likely to have supported the development of the phonological representation of the word.

Mengoni et al. (2013) suggested that their use of print provided visual support for the phonological representation. This possibly made the words more accessible for children with DS as the phonological representation was supported by a visual representation so the difficulties with phonological short-term memory and hearing were somewhat alleviated.

The use of orthography has also been used in intervention targeting speech in children with DS aged 4;4-5;5 years (van Bysterveldt et al., 2009). This study targeted the pronunciation of words and included activities linking the graphemes of a written word to the phonemes in the spoken form. The hypothesis was that the phonological representations would be strengthened by the orthographic equivalents. The study led to statistically significant results in production accuracy on both trained and untrained words showing generalisation to untrained words.

It is therefore suggested that the use of print may be an effective explicit teaching method for those with DS, even for non-readers or those with limited reading skills. Furthermore, strategies that focus on the internal structure of the word, using the visual representations of sounds, may support the development of more accurate phonological representations.

6.1.5. Adequate duration and intensity of therapy

The intensity of input varies widely in language intervention research from a single session (Mengoni et al., 2014) to a year (Buckley, 1993). These single sessions are typically experimental designs where two conditions are compared, and immediate learning is measured without considering longer term learning. A feasibility study (Finestack et al., 2017) found minimal gains following a six-week intervention study targeting narrative skills and the authors themselves reported the short duration may be responsible for the lack of gains.

Studies that have focussed on measuring effective interventions, frequently provide much more regular intervention sessions across a week; twice a week (Camarata et al., 2006; Sepúlveda et al., 2013), three sessions per week (Finestack et al., 2017) or daily (Monday-Friday) sessions (Burgoyne et al., 2012a; Goetz et al., 2008). One study specifically measuring the effectiveness of intensity found children with DS learnt significantly more words when intervention was delivered in five one-hour sessions across the week compared to a one-hour session per week (Yoder et al., 2014).

In addition, the duration of the intervention sessions themselves varies considerably from one hour (Yoder et al., 2014) to more typically 18-40 minutes (Burgoyne et al., 2012a; Goetz et al., 2008; Sepúlveda et al., 2013; van Bysterveldt et al., 2009). The Burgoyne et al., study (2012a) consisted of a 40-minute daily session divided into a

20-minute reading strand and a 20-minute language strand, significant gains were found on taught vocabulary targeted in the language strand.

In summary, a small number of studies have found significant gains on vocabulary (Burgoyne et al., 2012a), morphology, semantics and syntax (Sepúlveda et al., 2013) and speech (van Bysterveldt et al., 2009) in interventions that have occurred in daily (Monday-Friday) sessions, lasting 15-40 mins over the course of 15-20 weeks.

6.1.6. Training others to deliver intervention

The evidence suggests that effective intervention for individuals with DS requires a high intensity, however it raises the question of who is able to deliver intervention at this intensity. Whilst SLTs are obviously trained in delivering therapy, the reality and cost of an intervention that requires daily input from an SLT is likely to be prohibitive, regardless of how effective the intervention may prove to be.

Therefore, it may be unsurprising that a range of parents and professionals have been involved in the delivery of intervention in previous studies. Parents have been shown to be effective in delivering intervention on vocabulary in pre-school children with DS (e.g., Girolametto et al., 1998) as have pre-school professionals (e.g., Yoder et al., 2014). It seems an obvious choice for those spending most time with the child to deliver the therapy, if the intervention can be delivered effectively in this way.

In school-aged children with DS, a study using SLTs found effective gains on morphology, semantics and syntax (Sepúlveda et al., 2013) but again, the application of any such study is likely to be prohibited by the cost and availability of therapists. Therefore, a number of studies in the UK have used teaching assistants (TAs) to deliver intervention to this group. In the UK, children with DS typically receive 15-32.5 hours per week of additional adult support in the classroom delivered by a TA (Hargreaves et al., 2021). The use of TAs has been found to be effective in delivering intervention targeting vocabulary (Burgoyne et al., 2012a) and letter sound knowledge and early word reading (Goetz et al., 2008).

All of the studies above that involve parents, pre-school professionals or TAs to deliver intervention include training and supervision of these adults by an SLT or psychologist.

Therefore, whilst it is possible to train parents and TAs to deliver intervention to children with DS, training, supervision and regular support is an important factor.

6.1.7. Explanation of grammatical rules

Many language intervention studies designed for children with DS have taken an implicit approach to targeting language intervention (e.g., Girolametto et al., 1998; Yoder et al., 2014). The literature reports that children with DS have a strength in learning taught items (e.g., single words (spoken and written), letter names) but struggle to generalise strategies (e.g., phonological awareness skills). This raises the question as to whether a more explicit teaching approach could be beneficial for children with DS. The Downs Syndrome Association suggest Shape Coding can be "very useful for children with DS" although the research is limited (Downs Syndrome Association, n.d.). Shape Coding takes an explicit teaching approach using shapes and colours to code grammatical structures. A pilot study evaluating the effectiveness of shape coding with 11 pupils with moderate learning difficulties and complex needs (aged 12-14 years) included six pupils with DS (Tobin & Ebbels, 2019). Significant gains were found for tense and plural agreement marking in copular and auxiliary structures for eight of the 11 participants and although sample size was small, some generalisation to untreated items was reported. This intervention was based on the rationale that children who have difficulty learning grammar implicitly may benefit from some explicit teaching of grammatical rules. Furthermore, children with DS who have relative visual spatial strengths, may particularly benefit from this type of visuospatial based intervention that uses shapes, colours and arrows to support understanding. A similar language coding system using colour alone (rather than shape and colour), has benefitted narrative skills (Hettiarachchi, 2015) and three-word phrase development (Bibi et al., 2019) in children with intellectual disabilities including a small number of children with DS. Whilst limited, this evidence (particularly the Tobin & Ebbels, 2019) study) suggests children with intellectual disabilities including those with DS may benefit from a more metalinguistic approach to targeted language intervention and furthermore that this may support generalisation.

6.1.8. Links to own experiences

Whilst there is some evidence of generalisation to untaught items for this population (e.g., van Bysterveldt et al., 2009) discrete gains on taught items are more common

(e.g., Burgoyne et al., 2012a). One factor that may help facilitate generalisation is the use of the intervention target within a more functional context. Intervention that is linked to personal experience has been suggested to be beneficial in a small-scale feasibility study with four girls with DS aged 10-15 years (Finestack et al., 2017). The intervention included using a tablet to enable participants to take their own photos of their everyday activities which were then used to recall, create and retell personal narratives. Improvements were minimal, with only two of the four participants making small gains in MLU. However, as the authors themselves point out, the short duration of the intervention (six weeks) may have limited the impact.

In the Burgoyne et al. (2012a) study, photographs of the child taken in school or sent in by parents were encouraged as part of the taught vocabulary targeted in the intervention. In addition, direct links between the vocabulary and the child's own experience were made. Interestingly, taught vocabulary was the only language measure that showed significant gains following the intervention as no generalisation was observed.

This evidence suggests that linking intervention targets to everyday experiences of individuals with DS could potentially be beneficial. This may support generalisation rather than relying entirely on the student to extrapolate this learning for themselves.

6.2. Therapy techniques used in the PaTI intervention

The PaTI intervention programme was developed specifically for this project by the researcher. It includes a number of therapy techniques which were identified in the review above as being effective in interventions with children with DS. The overview, manual and resources can be found here: (link removed due to use of photos)

6.2.1. Use of modelling and imitation

Modelling and eliciting imitation were embedded in many of the effective interventions. Therefore, in the PaTI programme the TAs were given specific instructions on how to deliver the intervention activities, including example scripts, regarding accurate modelling and eliciting imitation. This detail was provided for every activity within the manual. The adult was prompted to model the present progressive tense and RSPT

within the activities and importantly to ensure the child imitated the correct production. If, at any time, the child did not spontaneously produce nor repeat the targeted grammatical morphemes, they were asked to repeat either the sentence or the verb with the consistent marker(s) again. This encouraged them to pay attention to the model and practise the correct form to support the development of a more accurate phonological representation and motor programme.

6.2.2. Frequency of modelling in context

In line with the research supporting the effectiveness of exposure to multiple exemplars of target structures, the same four targeted verbs were used repeatedly in context throughout each week of the PaTI intervention. This ensured the child was presented with many repetitions of each verb with the RSPT marker *-ed* both verbally (from the TA) and visually through the written form. They also received multiple repetitions of the spoken and written form as they completed the activities each day. Furthermore, there were several review activities which supported the child to review their work from the previous day and week(s), thus providing additional representations throughout the 10 weeks.

Many successful interventions include the technique of providing linguistic and semantic context for the target vocabulary (e.g., Mengoni et al., 2014; Sepúlveda et al., 2013). Examples of semantic context have included creating the backdrop of an alien land for teaching new vocabulary embedded in a story set-up (e.g., the alien is going to need....) (Mengoni et al., 2014) and linking to the child's own experience using photos (Finestack et al., 2017). This technique is therefore included in a number of the PaTI intervention activities, providing context through the use of photos, stories, acting out sequences, video review, use of own experience etc.

The four verbs for each week were carefully selected to support their use in the context of a story (e.g., "The Pizza" story included *squeeze*, *roll*, *chop*, and *cover*). This story then became the focus of an activity on day two, acting out the four verbs. For example, the children pretended to make their own pizza with playdoh. Acting out activities included the use of puppets, role play of events and stories and real events (e.g., growing cress).

6.2.3. Ideal listening conditions

Following the hypothesis that many previous studies have been carried out in relatively ideal listening conditions and the recommendation from the Burgoyne et al. (2012b) teacher's handbook, a quiet room with limited distractions was made a priority in the PaTI programme. The information and consent sheets for head teachers specified the provision of a quiet room for assessment and TA training included this recommendation for the daily sessions.

6.2.4. Use of orthography to support the spoken form

The evidence for the use of orthography led to this being a key technique throughout the PaTI intervention to prompt the child to use the targeted forms in a sentence. The child either read the targeted sentence independently or was supported to read/repeat after the adult model (for non-readers or those who could not read the sentences). This technique was used in all the activities that included the action pictures (which had the corresponding written sentences underneath), the story activity and the reviewing of previously completed written work (completed each day).

Action pictures were introduced as the first activity of day one every week and were then used in the majority of activities throughout the week. These action pictures were presented in pairs, one depicting a person mid continuous action and one depicting the action completed (see Figure 1).

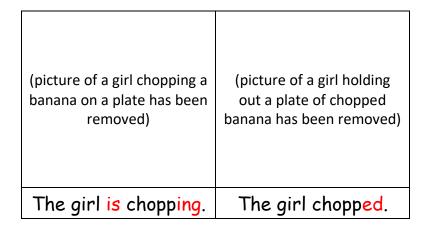


Figure 1 Action picture pair example

As shown in Figure 1, the written sentence was presented under each picture. Each time the pictures were used, the TA supported the child to read/repeat the sentence

with the accurate morphology. If the child made errors, the TA was instructed to point out the word or morpheme the child had omitted and ask them to repeat accurately. To provide reminders, the targeted morphemes were highlighted in red.

Intervention activities included using the highlighted morphology to identify whether sentences were in the present progressive tense or the RSPT. For example, the child was asked to sort the action pictures into two separate piles: one for *is happening* pictures and the other for *finished* pictures. These terms were taught as part of the intervention and the relevant morphology (-is, -ing and -ed) was marked in red so that the child could initially match the pictures to the correct term by matching the orthography of the grammatical morphemes (Figure 2).

is happening	finished

Figure 2 Sequencing board to map the morphology from the sentences to the appropriate tense/time

In addition to presenting the orthography to visually support the child to say the morphemes, a second orthographic technique was used. Every day the child was required to write words and sentences in the RSPT. The accurate spelling, using these morphemes, was a focus to further visually support the child's phonological awareness and accurate representation of the phonological representation. Children who were unable to write, used cut up words and letters to build the words and sentences. Therefore, they were still required to select and add the *-ed* to the verb root, thus still using the orthography.

6.2.5. Duration and intensity

The research evidence showed that interventions that have occurred in daily (Monday-Friday) sessions, lasting 15-40 mins over the course of 15-20 weeks have been

effective (e.g., Burgoyne et al., 2021; Sepúlveda et al., 2013; van Bysterveldt et al., 2009). The PaTI intervention took a 10-week format with daily 20-minute intervention sessions (Monday – Friday). TAs already working in the child's school were recruited and trained to deliver the intervention, enabling this high level of duration and intensity that is suggested to be required. In addition, an SLT visited fortnightly to support the TAs and ensure adherence to the programme. This duration and intensity is broadly supported by the research and furthermore it is in line with the blocks of therapy frequently offered by the NHS, making it potentially realistic in terms of existing provision.

6.2.6. Use of trained teaching assistants and regular speech and language therapist visits

The training of parents and/or TAs allows a frequency of intervention recommended by many studies (e.g., Burgoyne et al., 2012a; Goetz et al., 2008) that is otherwise unachievable. In this study, TAs received one day of training on the intervention before starting daily delivery. The SLT visited the schools every two weeks and observed the TA deliver the session for that day, providing feedback and support. The SLT observations were videoed and the sessions was rated for fidelity as well as factors including organisation and behaviour. In addition, the TAs received email and telephone support from the SLT.

6.2.7. Explanation of grammatical rules

In addition to the more implicit approach of providing multiple exemplars in context, an explicit approach was included to teach the grammatical rule for the RSPT. This combined implicit and explicit approach has been reported to be successful for individuals with intellectual disabilities including those with DS (e.g., Tobin & Ebbels, 2019). Included in the manual were specific instructions and guidance for TAs on questioning. This technique focussed on the importance of ensuring that the child understood what they were doing and why. Therefore, questions such as "what do you need to add to show it's finished/in the past?" and "why are you adding -ed?" were used throughout the activities.

6.2.8. Links to own experiences

In order to link therapy with the child's own life experiences, children were videoed carrying out an action until completion. Images of the action in progress (e.g., child chopping playdoh) and the completed action (e.g., child showing a plate of chopped playdoh) were captured. During the video, the TA commented on what was happening using the target verb (e.g., Isabelle is chopping, she is chopping the playdoh). After approximately 30 seconds the TA asked the child to stop and then modelled the RSPT target (Isabelle chopped the playdoh). The use of video had three advantages. Firstly, it allowed the TAs to use models of the targeted verbs and morphemes in context (see earlier in this chapter (6.2.2)). Secondly, it supported the child to talk/write about their own experience (rather than the pictures/drawings of others provided). The video was watched back by the child during the session to write about what they had just done and then it was used the following day to look back and write about what they had done the day before (e.g., one activity was to write a postcard telling someone what they had done). This then used the targeted RSPT to talk about the child's own experiences of the previous day in an attempt to directly target generalisation. The third additional advantage of using videos was the support it provided regarding memory and language. The child did not have to remember and recall actions they had completed previously and it supported understanding of the word 'yesterday'. They also completed an intervention book every Friday which reviewed their previous work, linking the words to their own previous experience.

6.3. Summary

The intervention included multiple explicit and implicit strategies that aimed to teach the RSPT rule. It was hypothesised that these strategies would strengthen the phonological and semantic representation of the regular past tense morpheme -ed. The use of modelling in relatively ideal listening conditions aimed to increase the saliency of the morpheme, supporting the child to hear the accurate phonological form. In addition, the use of orthography visually showed the child the difference between the bare and inflected form. This aimed to use the visual short-term memory strengths associated with DS to develop more accurate phonological representations. The use of orthography and the explicit teaching of the rule aimed to develop the semantic

understanding of the rule associated with the RSPT in English. Grammatical morphemes are reported to be omitted more frequently when argument structure is increased (e.g., Grela & Leonard, 2000; Song et al., 2009). The authors concluded that limited processing capacity results in the units that are less well established being vulnerable. The more complex syntax that surrounds verbs (e.g., Black & Chiat, 2003) has been suggested as a potential cause of the difficulties with verbs (Hesketh & Chapman, 1998) and morphosyntax (Rondal, 2017) that are experienced by individuals with DS. It was decided that short utterances with the verb in final position would be used to reduce syntax complexity and potentially increase the phonological salience of the verb. This was supported by the evidence that grammatical morphemes are less likely to be omitted from verbs in final position (and more likely to be omitted from verbs in medial position) by all children (e.g., Blom, 2018; Hsieh et al., 1999; Song et al., 2009). The position in the sentence is suggested to have more of an impact on younger children with limited cognitive resources (e.g., Blom, 2018) which would presumably make morphosyntax that occurs at the end of the sentence more accessible to individuals with DS. This would potentially aid the hearing and phonological short-term memory to hear and retain these verbs and the associated regular past tense -ed. Furthermore, verbs and morphosyntax in final position is also reported to reduce the articulatory planning demands (Blom, 2018) which has potential benefits given the speech difficulties with DS.

7. Methodology

Ethical approval for this study was obtained from University College London ethics committee, project identification number: 6602/001. Informed consent was gained from parents, schools and participants before the study.

7.1. Overview of design

A randomised control trial was conducted with 52 children with DS comparing a newly devised oral language intervention 'PaTI' to a delayed intervention (business as usual) control group. A power analysis was conducted in Stata using the sampsi command. Assuming a pre-test post-test correlation of r = .8 for critical outcome measures (which is reasonable), using ANCOVA, with 30 participants per arm, we would have just over 80% power to detect a Standardized Mean Difference between groups of 0.45, p = .05, two-tailed. All participants completed the baseline tests and the Intervention Test Battery and were then randomly allocated into two groups using simple randomisation: Group 1 the intervention group (receiving the PaTI intervention in the first 10-weeks following these tests) and Group 2 the delayed intervention group (receiving "business as usual" for the first 10-weeks, followed by 10-weeks of the PaTI intervention). Children were recruited in two cohorts in consecutive school years (September-November 2016 and 2017). Participants were allocated to two groups using simple randomisation. This was done using the runiform function in Stata.

Trained TAs delivered the PaTI language intervention to the children on an individual basis in daily 20minute sessions in the children's schools.

All children were assessed at three timepoints: pre-intervention (t1), immediately following the 10-week PaTI intervention was completed by Group 1 (t2) and at approximately 12-14 weeks later when Group 2 had completed the 10-week PaTI intervention. There was a four-week period between Group 1 completing the intervention and Group 2 starting the intervention. This period included two assessment weeks as well as two school holiday weeks. In accordance with CONSORT (Schultz et al., 2010), details of the allocation of participants and intervention delivery is presented in Figure 3.

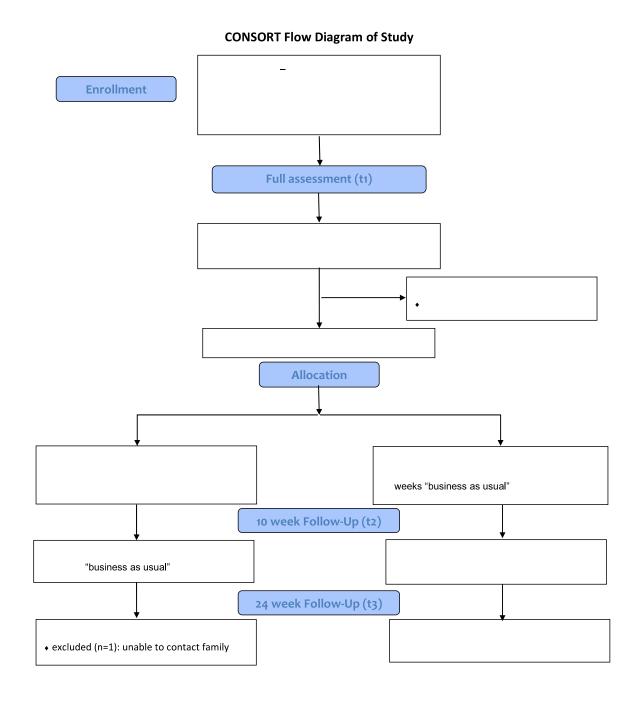


Figure 3 Consort diagram showing participant allocation and progress through the randomised control trial

Recruitment and consent: Children with DS aged 7-11 years were recruited across Hampshire, UK and the surrounding borders by contacting all local mainstream schools and local DS support groups. Four different sets of information sheets and accompanying consent forms were designed for recruitment:

- 1) for head teachers, requesting consent for their school to participate,
- 2) for parents, requesting consent for their child to be included in the study,
- 3) for TAs who may be responsible for delivering the daily intervention sessions,
- 4) for potential child participants.

The information sheets included relevant information for the target audience, such as an overview of the study including the purpose of the study, inclusion criteria and the role of schools, parents and the researcher throughout the project. The four sets of forms can be found in Appendix A.

The inclusion criteria were:

- a) Attending years 3-6 in mainstream school,
- b) Using English as their first language,
- c) Combining two or more words in spoken utterances, as reported by schools and/or parents,

Schools and families identified 55 children as potential participants. The researcher, an SLT with 12 years' experience of working with children with DS, met with each of the potential participants. Each child was shown an information sheet and consent form that were explained to them before asking for their consent. These forms were specifically designed for children of this age who have DS. They included photographs of the researcher, the activities that the child would be asked to complete and used simplified language (see Appendix A). This maximised the children's ability to understand what the project involved and their right to withdraw from the study at any point. This is an important ethical consideration as the learning difficulties associated with DS make understanding information presented verbally a challenge, therefore visual supports for understanding are recommended.

All 55 potential child participants completed two tests from the intervention test battery to confirm that they matched a further two selection criteria:

- d) Demonstrating a potential ability to produce the sounds to mark the past tense. This was measured using the phonological probe from the Test of Grammatical Impairment (TEGI) (Rice & Wexler, 2001),
- e) Failing to use the RSPT. This was measured using the Renfrew Action Picture Test (Renfrew, 1997) and the past tense probe from the TEGI.

Three of the 55 children did not meet criteria e. These three children were excluded from the intervention as they were already using the RSPT: they marked the simple regular past tense accurately in over 80% of responses on the TEGI past tense probe and responded in at least one past and one present tense form on the Renfrew Action Picture Test.

An information sheet was also designed for SLTs who were working with any child recruited to the intervention project. The information sheet provided a brief overview of the project including the randomised control design and specified they should continue with therapy as normal in accordance with this type of design. This can be found in Appendix B.

7.2. Participants and baseline assessments

The 52 selected participants with DS were aged 7-11 years at the start of the study and were recruited from 47 schools.

In order to gather information regarding family background, child health and development and speech and language provision, all parents/carers were asked to complete a Family Questionnaire (see Appendix C). The questionnaire was adapted from the Burgoyne et al. (2012a) study which gathered family background information as part of an evaluation of a reading and language intervention. The PaTI intervention focused on evaluating a language intervention targeting the RSPT and therefore the questionnaire was modified to include detail regarding speech and language therapy history. A total of 38 families (73.1%) returned a completed questionnaire. All were completed by parents, the details of which are summarised below.

7.2.1. Participant description

7.2.1.1. Family background

The majority of child participants were living in a household with two adults (94.8%), whilst only one lived with one adult and one lived with three adults including a grandparent. The average number of children in the family was 2.8 (range 1-7), with an average of 2.5 children living in the home (range 1-7). All children had English as

a first language and two families reported speaking an additional language at home (Dutch and Swedish).

7.2.1.2. Child health and development

All except two parents reported that their child had DS in the form of Trisomy 21, the remaining two parents reported 'unknown' when asked what form of DS their child had. This is in line with the literature, Trisomy 21 is the most common cause of DS accounting for 98% of cases (Roberts et al., 2007). Only two parents reported an additional diagnosis, both with a diagnosis of autism. During the intervention one additional child was also diagnosed with autism. Therefore 7.9% of child participants had a dual diagnosis which is broadly in line with the 5-7% reported historically in the literature (Kent et al., 1999).

All parents reported a high level of involvement in early services: Portage (100%), Occupational therapy (92.1%) or Physiotherapy (92.1%) to support development. When asked to report the age of first words, 36.8% of parents reported unknown. Of the 63.2% who could recall, a mean age of 21.6 months (range nine months to 48 months) was reported which is in line with previous research (e.g., 21 months Stoel-Gammon, 2001).

When parents were asked to report their child's current health status, 92.1% reported that their children were in good health. Of the remaining three families, one reported their child had regular health issues and surgery related to the trachea, one reported their child was awaiting open heart surgery and the third reported their child had arm and back pain, poor eating and sleeping resulting in chronic fatigue. Despite the high percentage reporting good health, 44.7% of parents reported that their children were taking regular medication for a number of medical conditions including constipation (eight), thyroid (three), difficulties related to sleep (three), asthma (two), heart (one), diabetes (one), eyes (one), vitamin D deficiency (one). These are all commonly associated with DS as discussed in Chapter 2 (2.1).

Hearing

This age group are recommended to have their hearing checked annually as detailed in Chapter 2 (2.1.1) and all parents reported having their child's hearing checked. A total of 52.6% had been tested within the previous six months, 10.5% within six months

to one year, 2.6% within one to two years and 31.6% reported date unknown. Parents were then asked if their child's hearing was within normal limits at the last test, to which 11 (28.9%) reported it was not and 13 (34.2%) reported their child was diagnosed with a hearing impairment. The reason for the discrepancy between these two figures is unknown. It is common for children with DS to be recalled for a subsequent test following an initial presentation of hearing loss. It could potentially be that the two children are currently under review and have not been formally diagnosed with a hearing impairment. Those parents who reported a hearing loss were asked to report the category of the child's level of hearing loss (e.g., mild, moderate, severe) and whether this hearing loss was in the right ear and/or left ear. The levels of hearing loss reported for both ears are reported in Table 2. A high percentage of children experiencing hearing loss in the left ear, also experienced loss in the right ear (90.9%) The same level of hearing loss in both ears was also commonly reported (70%). As discussed previously in Chapter 2 (2.1.1), conductive hearing loss is reported to drop in childhood to approximately 38% of children with DS experiencing this type of hearing loss at age 8 years (Austeng et al., 2013). This sample reported that 28.9% of children had some form of hearing loss at their most recent hearing test. Information about the type of hearing loss (conductive and/or sensorineural) was not collected and therefore the number of participants experiencing some form of hearing loss (sensorineural and/or conductive) would be expected to be higher than the 38% reported in previous research. The mean age of the sample is slightly higher than 8 years (M=8;9 years, range 7;25-11;25 years). However, the number of parents who reported that their children had hearing loss was less than expected from the literature.

Table 2 Reported hearing difficulties
Difficulties at the most recent hearing test reported by parents and shown as the percentage of the sample who completed the Family Questionnaire (N38) ^Percentage of those who reported 'other' was made up of fluctuating glue ear and grommets reported the same for both ears

Ear	Hearing difficulty	Percentage reporting difficulty
	Mild loss	18.4
	Moderate loss	7.9
Left ear	Severe loss	2.6
	Don't know	0
	Other (please specify)	10.5^
	Mild loss	13.2
	Moderate loss	10.5
Right ear	Severe loss	2.6
	Don't know	0
	Other (please specify)	10.5^

Table 2 shows 10.5% of parents reported 'other' when asked to give detail of the hearing impairment. Of this 10.5%, all reported their child had fluctuating hearing loss and all except one of these participants had a history of grommets being fitted (this information was repeated for both ears for all participants). Of the total number of participants, 31.6% had received grommets in the past. When asked about history of ear infection, 15.7% of all parents reported repeated bouts of ear infections.

Whilst parents were asked to report their child's hearing at the most recent hearing test, only 52.6% had been tested in the previous six months. This, plus the fluctuating nature of the hearing difficulties experienced by this population does not provide information about the child's hearing during the course of the intervention.

Vision

All participants reported having their child's vision tested in line with the guidance in the UK (DSMIG, 2012) as outlined in Chapter 2 (2.1.2) It was reported that 68.4% of the children did not have vision within normal limits. Of those reporting difficulties with vision, 63.2% reported wearing glasses. Table 3 lists the type and range of visual difficulties reported for the participants.

The reported visual difficulties shown as the percentage of the sample who completed the Family Questionnaire (N 38) *Percentage of those who responded 'don't know' but reported their child had a visual difficulty. ^ other was made up of Nystagmus (7.9%), cataracts (2.6%) and acuity (2.6%).

Table 3 Reported visual difficulties
Reported visual difficulties shown as the percentage of the sample who completed the Family Questionnaire
(N38) *Percentage of those who reported 'don't know' but reported their child had a visual difficulty ^other was
made up of Nystagmus (7.9%), cataracts (2.6%) and acuity (2.6%)

Eye	Visual difficulty	Percentage reporting difficulty
Left eye	Long-sighted	31.6
	Short-sighted	13.2
	Astigmatism	23.7
	Accommodation	7.9
	Squint	7.9
	Don't know*	5.3
	Other	18.4^
Right eye	Long-sighted	36.8
	Short-sighted	15.8
	Astigmatism	28.9
	Accommodation	7.9
	Squint	5.3
	Don't know*	5.3
	Other	18.4^

The visual difficulties reported are therefore roughly in line with the literature discussed previously in Chapter 2 (2.1.2). The sample reported 57.9% of children experienced one or more refractory difficulties (long-sighted, short-sighted and/or astigmatism) comparable to the literature (Woodhouse et al., 1997). Parents also reported nystagmus and cataracts under the 'other' column which are also reported more frequently in children with DS. Perhaps surprisingly only 7.9% reported difficulties with accommodation (maintaining focus as the distance of an object varies) despite the literature reporting 92% of children with DS have difficulties with accommodation by 48months (Woodhouse et al., 1997). Similarly, only one respondent reported that their child had difficulties with acuity despite the literature reporting increasing incidence from two years (Postolache, 2019). It is possible that, without a specific option to select acuity as a difficulty, parents did not think this information was relevant. Alternatively, given the high incidence associated with DS (80%, Postolache, 2019), perhaps this information was assumed. However, accommodation is also significantly and surprisingly lower that the literature reports. This perhaps reflects the knowledge of opticians that little can be done to remedy this condition. However, it is essential information for those working with this population and developing intervention as outlined in the Downs Syndrome Association's campaign 'Think Big Think Bold' (DSA, 2013).

Handedness

The family questionnaire data also revealed 26.3% of participants were left-handed, 55.3% were right-handed and 2.6% reported ambidextrous. This question was not answered by the remaining seven parents. Research on people with DS looking at handedness has shown a significantly higher percentage (35%) are not right-handed (either left-handed or show no hand preference) when compared to a typically developing group (18%) (Pipe, 1987). This increased non right handedness is reflected in the current sample.

7.2.1.3. Speech and language therapy provision

Questions 22-28 of the questionnaire asked about current speech and language therapy provision. Question 28 asked parents to detail their child's current therapy target(s) or to provide a copy of their most recent therapy programme.

Recency of therapy

Only 7.9% of parents who had returned their questionnaire reported that their child had been discharged from therapy or had not received therapy in the past two years. The length of time since the remaining 92.1% of children had seen an SLT is shown in Figure 4.

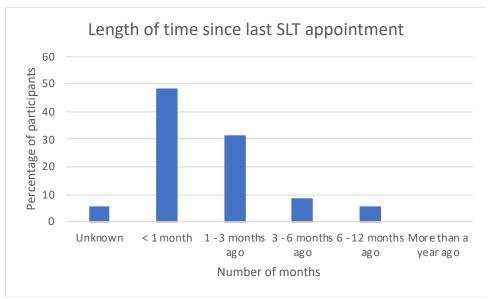


Figure 4 Duration since last SLT appointment
The figure shows the number of months since the child's last SLT appointment as reported by parents (N35)

The majority of children (48.6%) had seen an SLT in the last month with only 14.3% having not seen a therapist in over 3 months.

Provision of therapy

Participants were asked about the provider of any speech and language therapy they were receiving, and responses are shown in Figure 5.

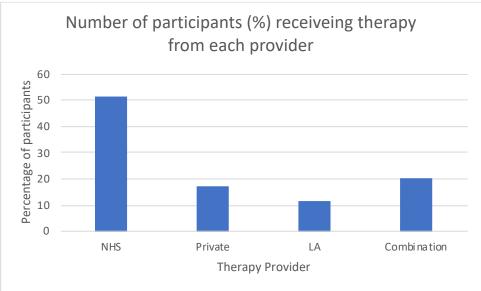


Figure 5 Percentage of participants receiving therapy from the various providers

NHS provision accounted for therapy provided to 51.4% of participants, 17.1% were receiving therapy funded privately (by the family) and 11.4% were receiving therapy funded by the Local Authority. A combination of two providers were providing therapy to 20% of children. This combination was an NHS and private provider in every case.

Frequency of therapy

The frequency of therapy input was calculated for the three different providers (NHS, private, LEA) and is shown in Figure 6. Where children were seeing an NHS and private therapist, the frequency of these providers has been separated for this description of frequency.

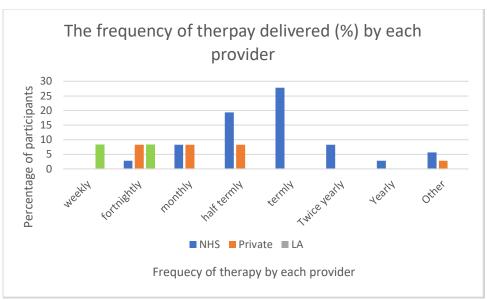


Figure 6 Frequency of therapy provided for participants divided by provider

The local authority provided therapy most frequently (weekly or fortnightly) with private therapy the next most frequent (fortnightly-half termly). NHS provision ranged dramatically (fortnightly-yearly). Where children were receiving both NHS and private therapy, the private therapy was delivered more frequently. Three parents selected 'other'. One reported receiving private therapy delivered three weeks out of four. For the remaining two participants who were reporting NHS frequency, one reported they were seen "ad hoc" and the other reported they had not seen a therapist in the last year.

Therapy targets

The questionnaire also asked for information regarding SLT targets, requesting parents to either list current targets or to attach their child's most recent SLT report. Over half of parents (60.5%) included information regarding SLT targets whilst 13.2% of participants did not complete this question (all had reported currently receiving SLT). Of the total number of parents, 7.9% reported their child had been discharged or not seen for two years and therefore did not have current SLT targets. Surprisingly, 18.4% of parents/carers who reported their child was receiving therapy, did not know what the current targets were.

For the 60.5% who provided information on targets, this information was reviewed and categorised by the researcher into the following areas: 1) speech 2) vocabulary and concepts 3) syntax (which included combining words, question words and conjunction targets) 4) morphosyntax 5) social 6) feeding 7) oral motor. Grammatical morphology

was classified separately to syntax as the current intervention is specifically targeting the use of a grammatical morpheme. Figure 7 shows the percentage of children receiving therapy in these areas. It should be noted that children could have targets in more than one area.

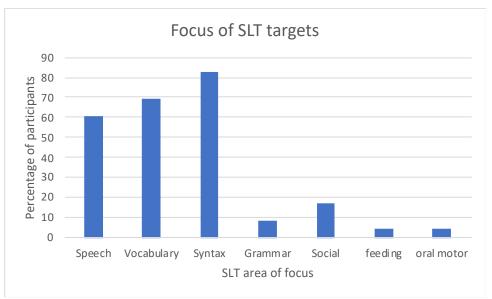


Figure 7 Participants' current SLT targets categorised by speech and language target focus

The most common targets covered syntax (82.6%), vocabulary (69.6%) and speech (60.8%). Targets relating to social use of language (e.g., requesting clarification, staying on topic for a number of conversational turns with a peer) were reported for 17.4% of children. Only two participants had targets relating to grammatical morphology, one was targeting past tense and the other, the use of *is*.

7.2.1.4. Summary

The information regarding health and development shows the sample to be fairly typical when compared to the literature in this area. The participants were generally in good health with 44.7% reporting medication for additional health conditions, all associated with DS. The proportion of children experiencing hearing difficulties (29.7%) and refractive visual difficulties (57.9%) was in line with the literature.

No published data could be found regarding typical speech and language provision for individuals with DS in the UK. A recent survey in Ireland reported limited services for individuals with DS across all ages (Frizelle et al., 2022). One national study of Norwegian third graders with DS (reported in Smith et al., 2020) stated one third of children did not receive systematic language intervention. No other data on provision

could be located. There are several good practice guidelines reporting recommendations regarding speech and language therapy and assessment for children with DS, for example "Speech and language therapy assessment and intervention comprehensively addressing the individual's needs should be consistently available throughout their education" (All Party Parliamentary Group on DS, 2012). Furthermore, it has been recommended that therapy plans for children with DS at primary school should cover four areas of work; speech, vocabulary, grammar and communication (Buckley & Le Prèvost, 2002). A recent systematic review highlighted the "need for prioritisation of language interventions in the children's curriculum" (Smith et al., 2020). Therefore, it is perhaps unsurprising that syntax related targets were reported most frequently. However, the comparative lack of targets (only reported for two participants) relating to morphosyntax is surprising given the difficulties discussed in previous chapters.

7.3. Assessments

All participants were assessed at three timepoints: pre-intervention (t1), after half of the participants (Group 1 intervention group) had received the intervention (t2) and when the remaining half (Group 2 delayed intervention group) had received the intervention (t3) (See Consort Diagram Figure 3).

All assessments were administered by the researcher and carried out in each child's school in an individual session. The researcher was an experienced SLT who was:

- 1) familiar with the speech and communication patterns (including error patterns) of children with DS.
- 2) experienced and trained in managing behaviour of children with DS,
- 3) experienced in assessing this age range of children with DS on a range of speech and language assessments.

The school were asked to provide a suitable quiet environment with a table and chairs. TAs and parents were invited to attend the assessment session(s) with the child to provide some assistance with behaviour and communication challenges. Before the assessment session began, any adults present were given clear instructions regarding the guidelines for administering assessments and instructions, such as not providing

cues that would alter the child's response. Assessments typically took place over one to two half days on separate dates and regular breaks were provided. This was to support attention and reduce fatigue. More than two visits were offered if necessary and one child received four visits.

The assessor was not blind to the group the child was assigned to which has some potential bias issues which will be discussed in the limitations. To control for any potential bias, the researcher and two research students blinded to the purpose of the study rated 15.8% of videorecorded RAPTs and Retell Narratives. Between-observer agreement was calculated for the specific measures of grammar using intraclass correlation coefficients (ICC) with absolute agreement and single measures in a two-way mixed effects model. For the RAPT grammar, the ICC was .999 (Information was .942). For the use of the RSPT of the Narrative Retell, the ICC was .998. Therefore, excellent between-observer agreement was demonstrated across these measures.

7.3.1. Baseline assessments (t1 only)

The baseline assessments included a measure of non-verbal mental age (Ravens Coloured Progressive Matrices) (Raven, 2008) and of word reading and letter sound knowledge (York Assessment of Reading Comprehension) (Snowling et al., 2009). In addition, a range of language assessments were administered including receptive and expressive vocabulary measures (Receptive and Expressive One-Word Picture Vocabulary Tests) (Brownell, 2000), a receptive language measure (Test for Reception of Grammar) (Bishop, 2003a) and an expressive language measure (Clinical Evaluation of Language Fundamentals) (Semel, et al., 2000). These assessments are outlined below together with the rationale for selection.

Ravens Coloured Progressive Matrices (Raven, 2008):

This assessment was used to assess non-verbal mental age. It has been designed for children from 5-11 years as well as for adolescents and adults with intellectual and physical disabilities. The child is shown a picture with a piece missing and is required to choose the correct missing piece from six possible options. There are 36 items within the assessment. It was chosen as it is quick to administer, does not require any knowledge of literacy and has minimal reliance on understanding spoken language. It has been used in other studies with participants who have DS (Laws et al., 1995;

Laws, 2002; Laws & Bishop, 2003; Perovic, 2006) with ages from 7-years-5-months to 39 years. This assessment has also been specifically investigated for use with children with DS and whilst the findings on suitability are mixed (Gunn & Jarrold, 2004) there is some supportive evidence (Facon & Nuchadee, 2012). This assessment would allow analysis of any associations between non-verbal mental age at the beginning of the intervention and any progress made during the intervention.

York Assessment of Reading Comprehension (YARC) (Snowling et al., 2009):

This assessment was used to obtain a general measurement of reading and print knowledge. It is suitable for children aged 4-16 years, requiring participants to have some emerging reading skills. The following two subtests of the YARC were administered:

- i. Early word reading subtest the child is asked to read a total of 30 words: 15 regular words decodable from spelling (e.g., w-e-n-t went) and 15 exception words with irregular spelling that cannot be decoded (e.g., giant).
- ii. Letter sound knowledge score subtest the child is asked to provide sounds for 11 single letters (e.g., /k/ for *c*) and six digraphs (e.g., /ʃ/ for *sh*). Letter names were counted as incorrect.

These two subtests were chosen as they are quick to administer and both the early word reading subtest (Burgoyne et al., 2012a; Mengoni et al., 2013) and the letter sound knowledge subtest have been used in previous studies with children with DS of similar ages (Burgoyne et al., 2012a). This assessment would allow analysis of any associations between these reading skills at the beginning of the intervention and any progress made during the intervention. This was particularly relevant as the intervention involves matching, recognising and manipulating the written form of words and letters.

Receptive One-Word Picture Vocabulary Test (ROWPVT) (Brownell, 2000)

This assessment was used to provide a measure of receptive vocabulary and is designed for children from two-years through adulthood to 70+ years. The child is shown four coloured pictures and asked to select the correct picture when the researcher verbally presents a word. A child must establish a ceiling score (established by six incorrect responses out of eight) and a basal score (established by eight consecutive items). The raw score is then calculated by subtracting the number

of errors between the basal and ceiling score from the ceiling score. This test was chosen because it is simple to administer, and the coloured pictures are appealing to children. Also, it has been used successfully before with younger Dutch-speaking children with DS (Deckers et al., 2019) as well as to evaluate an intervention for children with DS from 5;02-10 years in a study by Burgoyne et al. (2013). This age range was similar to the one used in the current study. This assessment would allow analysis of any associations between receptive vocabulary at the beginning of the intervention and any progress made during the intervention.

Expressive One-Word Picture Vocabulary Test (EOWPVT) (Brownell, 2000)

This assessment was used to provide a measure of expressive vocabulary and is designed for children from two years through adulthood to 70+ years. The child is shown a series of pictures and asked to name either the object (*what's this?*), the action (*what's s/he doing?*) or to give a category or a word that links the items (*what are these?* e.g., food, things that fly). Again, each child must establish a ceiling score (established by six consecutive incorrect responses) and a basal score (established by eight consecutive correct responses). The raw score is then calculated by subtracting the number of errors between the basal and ceiling score from the ceiling score. This assessment was chosen as it is simple to administer and features large, colourful and generally clear pictures. This assessment has also been used in previous research evaluating an intervention for children with DS of a similar age (e.g., Burgoyne et al., 2012a; Burgoyne et al., 2013). This assessment would allow analysis of any associations between expressive vocabulary at the beginning of the intervention and any progress made during the intervention.

Test for Reception of Grammar (TROG-2) (Bishop, 2003a)

This assessment was used to provide a measure of receptive language and is suitable for children from four years to adulthood and specifically states its usefulness with a range of clinical groups including people with learning difficulties and specific language impairments. Following two practice items, each target construction is presented in a block of four trials. Each trial consists of four picture options to choose from. The child is presented with a spoken sentence and asked to select the appropriate picture from the four. If a child fails to identify the correct picture for any of the four trials, that block is considered to be failed. A score is usually calculated by the number of blocks

passed and the test is discontinued when five consecutive blocks are failed. Whist this assessment has been used successfully with slightly older children with DS (Laws & Bishop, 2003), the receptive language difficulties experienced by children with DS often result in very low scores on this assessment including participants failing all or most of the early blocks (e.g., Frizelle et al., 2019; Joffe & Spyridoula, 2007). Therefore, scoring was adapted in line with other studies who have used this assessment with children with DS (Burgoyne et al., 2012a; Conners et al., 2018; Pennington et al., 2003). Each child's raw score was calculated to attempt to demonstrate the variability within the group that could be missed by calculating the number of blocks passed. For example, one child could score zero blocks passed with a raw score of zero (i.e., no items scored correctly on any of the first five blocks). Another child could score zero blocks passed with a raw score of 15 with three items scored correctly on each of the first five blocks. Both children would score zero if only blocks passed were counted, whereas their raw scores would discriminate between them. This assessment would then allow for better analysis of any associations between receptive grammar and any progress made during the intervention.

Clinical Evaluation of Language Fundamentals (CELF 4-UK): sentence repetition subtest (Semel, et al. 2000).

This subtest was used as a measure of expressive language even though it also places some significant demands on phonological short-term memory (a relative area of difficulty for children with DS as discussed in Chapter 2 (2.2.1). This assessment features a range of subtests designed for children from 5-16;11 years. The child is asked to listen to the assessor read out a sentence and then repeat back the sentence. The child's utterance is compared to the original sentence and any errors are recorded. Errors include omissions of morphemes, repetitions of a word/words, addition of morphemes, transpositions and substitutions. Although there are only two practice items, the attempts at repetition of practice items were extended to three to support understanding of the task. Also, all children started at item one regardless of age and continued until the discontinuation rule of five consecutive zero scores was met. Sentences were scored in the usual way: 3 = no errors, 2 = one error, 1 = two or three errors, 0 = four or more errors. The Recalling Sentences subtest from earlier versions of this assessment, the Clinical Evaluation of Language Fundamentals (CELF-R, 1987; CELF-3, 2000) has been used with children with DS from the upper

age group of the current study (10-19 years, Laws & Bishop, 2003) and across the range of the current study (Laws et al., (2016) age range 6;8-13 years) respectively. These earlier versions were designed for use with children from similar ages (from 5 years CELF-R, from 6 years CELF-3) as the current CELF-4 therefore suggesting this assessment would be suitable for the current study. This assessment would then allow for better analysis of any association between sentence repetition and any progress made during the intervention.

The Test of Early Grammatical Impairment (TEGI) (Rice & Wexler, 2001)

The TEGI assesses expressive grammar and is designed for children from 3-8 years. It has three subtests: the Phonological Probe, which was administered at baseline (t1) only and the Past Tense Probe and the Third Person Singular Probe which were administered as part of Intervention Assessment Battery (t1, t2 and t3). The Past Tense Probe and the Third Person Singular Probe have been used in a previous study with children with DS from 10-19 years (Laws & Bishop, 2003). Although the current study includes children from a younger age group, Laws and Bishop (2003) reported a relatively high level of success with 14 out of 19 participants with DS completing the assessment.

Phonological Probe: This subtest of the TEGI, aims to establish whether the child can articulate (or attempt to articulate) the sounds used to mark the RSPT and the third person singular in English. The child is shown five pictures, depicting a word that ends in one of the four target sounds /s/, /z/, /t/, /d/ (20 pictures in total). The stimuli design should be carefully considered when interpreting the results, as to whether a child is able to produce the sound combinations required when marking tense. The target sounds are only elicited in words that end in a vowel and final consonant (e.g., bed /bed/) There are no targets for final clusters or addition of an extra syllable. Therefore, it is not possible to know whether a child can produce clusters in words such as toast /təʊst/ or danced /dɑːnst/ or add an extra syllable e.g., collected /kəlektɪd/, teaches /ti:tʃɪz/.

These assessments were combined with those from the intervention test battery and administered in a set order (see Table 4) to ensure the same order for all participants.

The intervention battery tests administered at all time points are highlighted in Table 4 and described later in this chapter (7.3.2).

Table 4 Order the assessments were administered at baseline

The table shows the approximate duration and number of items of each assessment and any discontinuation rules (*assessments were administered first if the child was suspected to already be using the RSPT) (highlighted tests were administered at all timepoints)

Assessment order:		Approx. Duration:	No. of items	Any discontinue rules:
1. TROG-2	Pic selection	10-20 mins	80	5 con. blocks
2. Ravens CPM	Pic selection	15 mins	36	
3. RAPT*	Pic description	5-10 mins	10	
4. TEGI Phon.Probe	Pic name	3 mins	20	
5. TEGI Past Tense Probe*	Sentence completion	5 mins	18	
6. TEGI 3 rd Person Singular Probe	Sentence completion	5 mins	10	
7. TRSPTP taught block 1	Sentence completion	10	20	
8. CELF-4 RS	Sentence rep	5-10 mins	24	
9. ROWPVT	Pic selection	5-10 mins		6 out of 8 con. errors
10.EOWPVT	Pic naming	10 mins		8 con.errors
11.URSPTP untaught block 3	Sentence completion	10 mins	20 mins	
12. YARC word	Word reading	5 mins	30	
13. YARC letter	Letter sound	5 mins	17	
14. Bespoke Narrative Retell	Story retell	2 mins	4 picture story	
15.TRSPTP taught block 2	Sentence completion	10 mins	20	
16.Bespoke RSPT sentence rep	Word rep	3 mins	10	

Abbreviations: TROG-2, test for reception of grammar; Raven's CPM, coloured progressive matrices; RAPT, Renfrew Action Picture Test; TEGI, Test of Early Grammatical Impairment; Phon, phonological; TRSPTP, taught regular simple past tense probe; CELF-4 RS, clinical evaluation of language fundamentals recalling sentences; ROWPVT, receptive one-word picture vocabulary test; EOWPVT, expressive one-word picture vocabulary test; URSPTP, untaught regular simple past tense probe; YARC, York assessment of reading comprehension; RSPT, regular simple past tense (sentence repetition); TNW, total number of words; con, consecutive.

7.3.2. Intervention test battery (t1, t2 and t3)

The intervention test battery assessments specifically measured the child's use of expressive language. These tests included two published tests of expressive language, including one that specifically measures the use of grammatical morphemes. In addition, a number of bespoke assessments were designed and the

development of these is detailed below. As the PaTI intervention targets expressive language (specifically the use of the RSPT), these assessments were carried out at all timepoints (t1, t2 and t3). These tests are described below together with the rationale for choice.

The Test of Early Grammatical Impairment (TEGI) (Rice & Wexler, 2001): Past Tense Probe

In this subtest of the TEGI, children are presented with 18 pairs of pictures. Each pair shows a person carrying out an event followed by the same person having completed the event. The second picture includes visual cues to indicate that the event is complete (e.g., a boy looking in admiration at the fence he has finished painting). The child is told the sentence for the first picture while the researcher points to the picture (e.g., here the boy is raking), then the researcher points to the second picture and says, now he is done, tell me what he did. If the child does not attempt an answer, they can be prompted by a repetition of the original prompt followed by the alternate prompt s/he..... Two practice examples are given at the start and, if the child does not answer these correctly, the administrator gives the correct response (only for the two practice items). Ten regular past tense verbs and eight irregular past tense verbs are targeted. However, if a child gives an appropriate verb (regular or irregular) as a response, this is counted as correct (e.g., target jumped in the puddle would score correct for splashed or swam). When this test was completed, raw scores were calculated for irregular and regular verbs separately as the intervention only focussed on the RSPT. This allowed for comparison across the two different verb types. Any overgeneralisation of the RSPT used to mark an irregular verb (e.g., drinked /drɪnkɪd/) was also calculated separately.

The Test of Early Grammatical Impairment (Rice & Wexler, 2001): *Third Person Singular Probe*

This subtest consists of 10 pictures of people in different roles (e.g., teacher, firefighter, nurse). The child is told the role (*here is a teacher*) and is then asked to say what that person does (*Tell me what a teacher does*). If the child does not attempt an answer, they can be prompted by a repetition of the original prompt followed by the alternate prompt *A teacher...*. One practice example is given. If the child does not answer this correctly, the administrator gives the correct example. Each response was

scored as correct/incorrect depending on whether the response appropriately included the third person singular -s (e.g., for *teacher* the child would be given a correct score for *teaches*, *writes*, *talks* etc.). This assessment was included to compare any progress on the targeted RSPT morpheme *-ed* to the untargeted tense related morpheme third person singular *-s*.

Renfrew Action Picture Test (Renfrew, 1997)

This assessment is designed for children from three to eight years. The child is required to look at 10 pictures and to describe each picture in response to a question presented verbally by the assessor. The child's responses should vary according to the tense the question is presented in. Example questions are:

- 1) What is the girl doing?
- 2) What is the Mum going to do?
- 3) What has been done to the dog?

The child's responses are then scored for:

Information – the key vocabulary and idea(s) portrayed in the picture, and Grammar – the child's use of morphosyntax.

These two scores are reported separately to allow for a comparison between the two areas of language. This assessment has been used with children with DS of a similar age range in a previous research study (e.g., Burgoyne et al., 2012a). This assessment would allow for analysis of any association between progress on the intervention and the information and grammar scores on this published assessment.

All of the standardised assessments administered were selected due to their successful use with children who have DS in previous intervention research. However, standardised tests are not designed (or standardised) for this population and children with DS are reported to make small discrete gains that may not be picked up by assessments standardised on typically developing children. Furthermore, tests that are closely related to the intervention format have shown to be effective (Buckley, 1993; Sepúlveda et al., 2013). Therefore, in addition to these standardised assessments, bespoke measures were used to elicit a large number of examples of the child's use of the RSPT. These measures also target the use of the RSPT in a

range of tasks that required different levels of response e.g., sentence repetition, picture description and narrative retell.

Bespoke Regular Simple Past Tense Probe (RSPTP)

The RSPTP is modelled on the TEGI Past Tense Probe as the TEGI has been used successfully with this population to elicit the use of RSPT (e.g., Laws et al., 2016). The TEGI only contains 10 examples of eliciting the RSPT with 10 different verbs whereas the RSPTP contains 60 examples of eliciting the tense: with 40 verbs that are taught in the intervention and 20 verbs that are not used in the intervention but matched for phonological form of the grammatical morpheme and checklist number associated with the order of acquisition according to Down Syndrome Education International's (DSEI) vocabulary checklists (DSEI, 2009). All 40 examples are included in the assessment to capture any small increases in the use of the RSPT that may be missed in the small sample in the TEGI. An additional 20 untaught examples are used to allow analysis of any transfer of progress to untaught items. The RSPTP is therefore divided into two probes, Taught Regular Simple Past Tense Probe (TRSPTP) and Untaught Regular Simple Past Tense Probe (URSPTP).

The RSPTP has the same design at the TEGI, two pictures are presented in parallel, the first one showing someone completing an event (e.g., a boy posting a letter) and the second one showing the same person having completed the event (e.g., the same boy stood next to the door without the letter). The TEGI is presented on a laptop and the pairs of pictures in the RSPTP were presented on an iPad to support the child's interest and engagement. In the same format as the TEGI, the adult describes the event in the first picture while pointing at the picture (here the boy is posting) and then the adult points to the second picture and says, now he is finished, tell me what he did. The word done, used in the TEGI, was replaced with the word finished as it is more commonly used in British English. Each of the 60 picture pairs are presented with this prompt. If the child responds with a generic repetitive phrase (e.g., he's finished, he's done), the assessor responds with yes, he has finished, but tell me what he did in the picture and repeats the whole prompt with the additional prompt now he is finished, tell me what he did, the boy..... There are two practice items. If the child correctly uses the RSPT, the assessor moves on to the second practice item. If the child does not use the RSPT (e.g., names a noun), the adult repeats the practice item

with the additional prompt (the (person)....). If the child then uses the RSPT, the assessor moves on to the next practice item. If the child still does not use the RSPT, the assessor provides the appropriate response (e.g., the boy posted) and asks the child to repeat the correct model. They then move on to the next practice item (whether the child repeats accurately or not). The RSPT response is only given for the two practice items and not for the remaining 60 items. Full instructions together with some example picture pairs are provided in Appendix D (the full bespoke RSPT materials for the taught and untaught items along with the record sheet can be found here: PaTI)

Each response is counted either correct (score 1) if the child uses a regular past tense verb (either with or without the additional prompt) or incorrect (score 0) if the RSPT is not used. Responses that include generic or repetitious responses (e.g., *finished*) are counted as incorrect (score 0). If the child uses a verb other than the target verb but marks the RSPT (e.g., uses *painted* instead of the target *coloured*) the response is scored 'correct'.

The verbs were predominantly selected from the Vocabulary Checklists 1, 2 and 3 (DSEI, 2009) which lists 810 commonly used vocabulary items. This strategy aimed to ensure that the verbs chosen were those that appear early in vocabulary development and therefore were likely to be known by the children. The verbs were also selected to represent the three phonological forms used to mark the RSPT in English:

- 1) voiced /d/ (e.g., crawled -> /kro:ld/) (N=14),
- 2) voiceless /t/ (e.g., jumped -> /dʒʌmpt/) (N=14),
- 3) additional syllable /id/ (e.g., planted -> /plq:ntid/) (N=6)

The verbs were represented using photographs of a range of different people and matched across the two subtests on age of expected acquisition based on the Vocabulary Checklists (DSEI, 2009) and the type of phonological form required. Given the visual difficulties of children with DS, some of the photographs may have proved challenging for some participants. For example, backgrounds were busy and for some, small items (such as a spoon in a cup) are likely to have been difficult to see. However, each target verb was presented orally in the first sentence (e.g., here the boy is mixing) and therefore whilst not ideal, the application of the RSPT was possible even if the picture was unclear.

Taught Regular Simple Past Tense Probe (TRSPTP):

The 40 verbs taught in the intervention are listed in Table 5. They are divided into two blocks of 20 that are administered separately to support engagement and reduce fatigue and loss of attention due to the large number of items. They include 18 voiced /d/ and 16 voiceless /t/ phonological forms as well as six phonological forms that require an additional syllable /ɪd/. The additional syllable form occurs less frequently in English and this is therefore reflected in the selection.

Table 5 Taught and untaught verbs included in bespoke assessments
The table Lists the taught verbs included in the intervention and the matched untaught verbs followed by the vocabulary checklist number they originated (Down Syndrome Education International, 2009) *verbs were additional verbs not listed in the checklists

Taught Regular Simple Past Tense Probe		Untaught Regular Simple Past Tense Probe
Taught verbs block Taught verbs block		Untaught verbs block
1	2	3
splashed (1)	washed (1)	kissed (1)
looked (1)	tickled (1)	clapped (1)
cried (1)	brushed (1)	stopped (1)
hugged (1)	wanted (1)	combed (1)
lifted (2)	climbed (2)	walked (2)
pushed (2)	played (2)	closed (2)
waited (2)	picked (2)	pulled (2)
opened (2)	smiled (2)	cleaned (2)
hopped (3)	jumped (2)	kicked (2)
crawled (3)	collected (3)	touched (2)
skipped (3)	dropped (3)	danced (2)
paddled (3)	turned (3)	called (3)
knocked (3)	licked (3)	counted (3)
filled (3)	rolled (3)	wiped (3)
dried (3)	swallowed (3)	showed (3)
covered (3)	stirred (3)	carried (3)
baked (3)	poured (3)	matched (3)
mixed (3)	laughed (3)	painted (3)
watered*	squeezed*	tied*
planted*	chopped*	twisted*

Untaught Regular Simple Past Tense Probe (URSPTP):

The 20 verbs not included in the intervention are also presented in Table 5. They are presented as a third block of 20, again to support the child's engagement. The same balance of each of the three phonological forms is included, voiced /d/(N=8), voiceless /t/(N=9), additional syllable /rd/(N=3). The untaught probe was designed to investigate whether children with DS were able to apply the RSPT to verbs they had

not experienced in the intervention. Children with DS have been found to make significant gains on taught items but have difficulty with generalisation (e.g., Burgoyne et al., 2012a). It was therefore expected that there may be gains on the verbs explicitly taught in the intervention (TRSPTP). However, to determine whether this use of the RSPT could be generalised to verbs that had not been explicitly taught, this test probe was designed.

Bespoke Past Tense Sentence Repetition Test:

This second bespoke assessment was developed to assess whether participants could repeat a short sentence containing a RSPT verb. In this assessment the child is presented with ten sentences ending with a verb marked with the RSPT *-ed*. The full list of sentences can be found in Table 6. These verbs are taken from the taught items and are always presented as the final assessment in the battery. This is to ensure there is no additional 'teaching' of the RSPT before the other assessments are administered.

Table 6 Bespoke RSPT sentence repetition targets
The table lists the sentences the children were asked to repeat in the bespoke past tense probe

Number	Sentence
1	The lady collected
2	The lady dropped
3	The man smiled
4	The girl licked
5	The boy rolled
6	The man swallowed
7	The boy stirred
8	The girl poured
9	The girl chopped
10	The lady mixed

As can be seen in the Table 6, the sentences take the form (determiner-noun-verb). This structure was based on the TEGI past tense probe which includes a description of the first set of two pictures "Here the boy/girl is...". Similarly to the TEGI, the sentence repetition task includes the use of some transitive verbs being used in an incomplete and unnatural way without an object (e.g. *the lady collected*). This reduced the phonological short-term memory and articulation demands on the child and improved the salience of the past tense form for the assessor. However, on reflection, this is not considered best practice and is discussed in the limitations in Chapter 9 (9.5.2).

An iPad is used to support understanding of the task. The assessor tells the child to listen to and repeat each sentence, saying exactly the same as the assessor. The assessor tells the child they are going to take turns to video the sentences. The assessor videos herself saying the sentence and then turns the iPad towards the child and asks them to do the same (i.e., repeat the sentence). All sentences have the same subject-verb structure (e.g., the boy posted) and the verbs consisted of the three phonological forms of the RSPT (voiceless /t/ N=4, voiced /d/ N=5, additional syllable /rd/ N=1). Each sentence is presented once only. After the child attempts all ten sentences, they are asked to repeat any RSPT verb forms (single word repetition) they have omitted in their sentence repetition (e.g., coloured). Each repetition is given a score of 3 if the whole sentence is repeated with no errors, a score of 2 if the sentence is repeated with the correct verb including the RSPT ending -ed along with at least one other word but contains some errors (e.g., omits determiner), a score of 1 if verb only is repeated including RSPT ending -ed and a score of 0 if the verb is omitted or produced without the RSPT ending.

Similarly, to the intervention design, the sentence repetition task involves repeating utterances with the RSPT in utterance final position. This design was selected to ensure that the RSPT marker *-ed* was salient and not impacted by a following word for example by coarticulation. This bespoke test also provided information about the ability of the child to produce the speech sound clusters required to mark the RSPT, omitted from the TEGI Phonological Probe (e.g., *the lady collected*).

Bespoke Narrative Retell Test:

This assessment was designed to elicit the child's use of the RSPT in a more spontaneous language sample. Children with DS have been shown to produce richer language samples and longer utterances in narrative tasks than in conversation and when picture supports are provided for retelling an event (Chapman et al., 1998). Therefore, it was decided that a story retell using pictures would be the best way to elicit language and attempt to produce comparable samples, controlling for the number of verbs and the regular forms as much as possible. This format also ensures that many examples of the RSPT are elicited in obligatory contexts.

Development of the test

Initially "The Bus Story" (Renfrew, 1995) was considered as a narrative assessment to use in this study. This story retell, standardised on typically developing children, was investigated with four children with DS. The Bus Story is designed for children from 3 years and is designed to elicit an expressive language sample that can be scored for information, sentence length and grammatical usage. It consists of 12 pictures that are presented three at a time whist the assessor tells the story. The child is asked to listen and then retell the story themselves. It includes 20 verbs that take the simple past tense form. Of these 20 verbs, 12 are irregular verbs leaving only eight examples of the RSPT form for use by the child. When these eight verbs are reviewed, only two appear in the first 810 words listed in the vocabulary checklists for children with DS (DSEI, 2009). Almost all of the verbs selected for the intervention were taken from these checklists (18 out of 20 for each block) in an attempt to ensure the vocabulary would be familiar to the children in the study. Therefore, it was not appropriate to use this test as a measure of a child's use of the RSPT following the intervention as the child may not be familiar with the vocabulary. This could result in the child not understanding the verbs used in the story and therefore being unable to understand the story.

In addition, the pictures presented alongside the story actually depict very few of the verbs (only two are pictured). This results in no picture cue to prompt the child to use the example verb or an alternative, familiar verb. It also places a large demand on verbal short-term memory which is a particular area of difficulty for this population (Jarrold et al., 2000). The Bus Story was piloted with four children with DS and resulted in a limited number of verbs produced and a considerable amount of unintelligible speech from one child.

The Get Ready for Learning Narrative Comprehension (Bowyer-Crane et al., n.d.) was also piloted with a further seven children with DS. This test was designed as a bespoke measure to gain an expressive language sample as part of an early language enrichment programme for preschool children. The original study scored the story for Story Grammar and Expressive language. Story Grammar measured the number of story grammar units produced based on its centrality to the story (e.g., information

relating to character, setting and events). Expressive language scores measured the number of words, number of different words and MLU.

This test has four pictures (versus the 12 in The Bus Story) accompanied by 14 sentences and includes the use of a puppet. The Story Grammar measure allows analysis to investigate the key information retold, information that was depicted was more commonly included in the four retells. Furthermore, during the pilot the children generally produced longer syntactic structures than those produced in the pilot with The Bus Story. Furthermore, examples of verbs were elicited both with and without tense markers. However, as would be expected from the literature, the samples from the seven children were very varied.

As the shorter, four picture format of the GR4L was more successful at eliciting language and the key concepts depicted led to a higher frequency of information included, this format was adopted to target the elicitation of nine verbs in the RSPT. Eight of the verbs were represented with some visual information pictured in the story (as a visual prompt), one verb was not visually supported as this could not be accomplished without adding another picture and extending the length of the test. The story sentences are shown in Table 7. The puppet proved to be a distraction for two of the children in the pilot and was not included in this bespoke design.

Table 7 Bespoke narrative retell materials
The table shows the pictures from the bespoke narrative retell, together with the accompanying 13 sentences
(verbs that are depicted are in hold)

(verbs triat a	re depicted are in bold)	
Picture:	Story:	Picture:
1	It was a sunny day. The boy played with the dog in the garden. The postman opened the gate.	

2	While the postman posted the letters, he said good morning to the boy. Suddenly the dog jumped over the step and ran off up the road.	
3	The dog ran all the way to the park. At the park he rolled in the mud and got very dirty. The boy was very cross. The boy carried the dog all the way home.	A
4	When he got home he washed the dog. The dog was very happy. The dog licked the boy. The boy laughed.	

Detailed instructions were provided (see Appendix E) and are summarised as follows. The child is shown the four pictures and instructed they are going to be told the story and they should listen carefully as when the story has finished, they will be asked to retell the story to the adult. As the assessor tells the story, they point to the relevant parts of the corresponding picture. Once the story is finished, the child is immediately told it is their turn to tell the story and the assessor returns to the first picture and points to the sun saying, *it was a....*. If the child does not respond or talks about something off topic, the assessor points to the next salient part of the picture and prompts with

one of three general prompts What happened here? What happened next? And then?. If a child uses an alternative tense (e.g., the boy is playing with the dog), the assessor is required to accept that response but to point to the next salient part of the picture and prompt with a RSPT prompt what happened next?, to provide obligatory context for the RSPT. General encouragement was given through eye contact and general, non-specific comments (e.g., ooh, oh dear etc).

Following the assessment session, the video was viewed in a quiet environment and the child's story was transcribed. The story was then scored for 1) total number of words (TNW), 2) number of different words, 3) MLU, 4) number of RSPT verbs used (PT). The MLU was calculated by dividing the total number of morphemes by the number of utterances produced by the child. As discussed previously in Chapter 3 (3.3), MLU can provide a general measure of language, but more detailed analysis is required to identify any specific gains in use of a particular morpheme. Therefore, the PT score was added.

This bespoke assessment was piloted with an additional four children with DS, not included in the 52 participant group. Three of the four children used simple syntactic structures in obligatory contexts for the RSPT (e.g., *boy play garden*). So, as this assessment seemed to discriminate between the children, no changes were made.

All of the intervention battery tests were carried out at all three timepoints. The order of administration for t2 and t3 is detailed in Table 8.

Table 8 Intervention test battery assessments

The table shows the order the intervention test battery assessments were administered at all timepoints (t1, t2 and t3), the approximate duration and number of items of each assessment

Assessment order:	Overview:	Approx. Duration:	No. of items
TRSPTP taught verbs block 1	Sentence completion	10	20
Renfrew Action Picture Test	Pic descript	5-10 mins	10
3. TEGI Past Tense Probe	Sentence completion	5 mins	18
4. TEGI 3 rd Person Singular Probe	Sentence completion	5 mins	10
5. URSPTP untaught verbs block 3	Sentence completion	10	20

6.	Bespoke Narrative Retell	Story retell	4 mins	4 picture
				story
7.	TRSPTP taught verbs	Sentence	10 mins	20
	block 2	completion		
8.	Bespoke RSPT	Word rep	3 mins	10
	sentence repetition	-		

7.4. Procedure

7.4.1. TA training

The TAs assigned to each child with DS were identified by the school and most commonly had the role of supporting the child who would be receiving the intervention for at least part of the day in school. As the intervention was delivered daily, schools were allowed to identify more than one TA to deliver the training across the week. The majority of schools (42 schools) identified one TA. Two TAs was the most any school identified. It was compulsory for all those who delivered the intervention to attend the full-day training. The TAs attended training in the two weeks of term leading up to the start date for the intervention. Therefore, TAs in the intervention group received training in January. Cohort 1 consisted of 16 TAs in the intervention group who received training in January 2017. Cohort 2 consisted of 10 TAs in the intervention group who received training in January 2018. TAs in the delayed intervention group for cohort one and two received training in the following April (cohort 1 consisted of 16 TAs who received training in April 2017, cohort 2 consisted of 10 TAs who received training in January 2018). The training took place either in a school or community hall/room and due to the spread of school locations, more than one training date was offered in a range of locations. Four schools were unable to attend one of the training dates/locations offered and in every case the training was held in the child's school on an agreed date ahead of commencing the intervention.

The training was delivered by the researcher (an SLT) using PowerPoint (slides can be found in Appendix F) and covered the following information:

Overall aims of the project:

The TAs were given a brief overview of the language profile associated with DS and specifically the difficulties with grammatical morphemes. The RSPT morpheme *-ed* was described together with the information regarding the various spoken forms

depending on the phonology of the verb. A list of all the verbs in the intervention, together with their correct pronunciation, was provided as part of the resource pack. The present progressive tense markers using the morpheme *is* and the present progressive *ing* was also explained, as this was contrasted in the intervention.

Manual and resource pack:

Each child was allocated an intervention manual and a pack of resources. This was given to the TA(s) at the beginning of the training day, together with specific instructions for each activity, the duration of each activity and the resources required. The majority of resources required were provided in an additional resource pack. The full manual and paper resources are provided (PaTI). The majority of the training covered each activity and the relevant resources, allowing the TAs to practise the activities in pairs.

Tailoring to individual needs:

Training included directions to the TAs on how to tailor the activities to meet the needs of the individual child. The intervention consisted of a number of different levels for the TAs to move through when appropriate. In addition, information covered supporting the wide range of language, reading and writing skills of children with DS.

SLT visits:

As part of the intervention, the researcher (an experienced SLT who had developed the intervention) visited each child approximately every two weeks during the 10-week intervention period. The dates for these visits were provisionally agreed with the TAs whilst attending the training. When more than one TA was delivering the intervention, the person visited alternated at each visit. The purpose of the visits is detailed further below.

General administration:

The training covered keeping a record of the delivery of the intervention. TAs were given a checklist to date each session they delivered and which of the activities they completed. The importance of the following aspects were stressed: accuracy of records and sticking to timings as well as what to do about missed sessions and any problems that arose. To keep TAs engaged throughout the intervention block and to

remind them of the next steps/important dates, they received newsletters reporting on success and examples of activities (Appendix G).

Parental involvement:

Parents were not invited to the TA training. This was an attempt to ensure parents were not tempted to provide additional input and practice at home. This was explained to parents and the child's record book (their work from the ten weeks), the manual and any remaining resources were instructed to be sent home at the end of the study (after the delayed intervention group had received the intervention). Parents did receive the newsletters which also included a prompt for any outstanding Family History Questionnaires. At the t2 assessment session, the workbooks were collected for the intervention group by the researcher for review and to ensure they did not go home. During the summer holiday (following the completion of the intervention by all families) the researcher held a meeting for parents to explain the details of the intervention, give back all of the work books and answer any questions (a copy of the parent information session PowerPoint can be found in Appendix H).

7.4.2. Intervention overview

The intervention was designed by an SLT experienced in providing speech and language therapy for children with DS. The intervention was specifically designed for this study and the therapy techniques were derived from previous effective intervention with children with DS, outlined in Chapter 6. The evidence-based techniques included the use of trained TAs who delivered the intervention in daily 20minute sessions over the course of 10-weeks as this duration and intensity is in line with previous research. Each week of the intervention took a similar format, introducing four verbs at the beginning of the week (40 verbs in total) and focussing on these verbs throughout the week. This repetitive structure was used to support TAs in becoming more familiar and confident in delivering the intervention and increasing the intensity as well as including the technique of providing multiple repetitions of the intervention target. A consolidation session was delivered on day five. This design of providing daily sessions, including a consolidation session on Friday, has been used in previous intervention with this population (e.g., Burgoyne et al., 2012a).

An overview of the 10-week intervention together with the therapy techniques used in each activity is provided in Table 9.

Table 9 Intervention overview

The table shows an overview of the 10-week intervention together with the therapy techniques used in each activity

Day	Activity	Duration (mins)	Activity description	Technique
	Verb introduction	3	A word web was used to introduce the targeted verbs and to teach the meaning of the word 'verb'.	Explicit teaching of grammatical rules
			The child was shown the present progressive tense action picture card for each verb and asked to place it on the web for the corresponding verb. The TA modelled the use of this tense for each verb and asked the child to repeat it. The child was then supported to read the sentence with the morphemes <i>is</i> and <i>ing</i> highlighted in red.	Modelling and imitation Use of orthography to support
			The child was presented with a written word card for each verb root (e.g. hop) and the spoken word was presented at the same time. They were asked to match the verb word card onto the action picture cards.	Modelling Use of orthography to support
day	Talking about tense	3	The child was presented with a table with two columns, the first headed <i>is happening</i> and the second <i>finished</i> . The grammatical morphemes, highlighted in red, were pointed out to the child.	Explicit teaching of grammatical rules Use of orthography to support
Monday			The TA modelled the headings and encouraged the child to repeat them. The child was then presented with all eight picture cards: four depicting the need for the RSPT and four depicting the need for the present progressive tense. All spoken sentences were modelled by the TA and the child was then supported to read them, including the relevant morphemes. If the morphemes were inconsistent with the target, the TA modelled again and the child was asked to repeat.	Modelling Linking to context Use of orthography to support Imitation if required
			The child was supported to sort the picture cards into <i>is happening</i> pictures and <i>finished</i> pictures using the highlighted orthography to match.	Use of orthography to support Linking to context
			As the child sorted, the TA asked the child about their choice e.g. "How do you know that is a finished sentence?", "why has that verb got an <i>-ed</i> at the end?" The child was supported to answer with modelling.	Explicit teaching of grammatical rules Modelling and imitation Linking to context
	Story Retell	16	The child was shown four pictures as they were told a simple story using the RSPT, which centred around the verbs for the week. For example, the story 'The Pizza'	Modelling Linking to context

			showed four photographs of a boy making a pizza, with each picture depicting one of the four verbs for the week <i>squeeze</i> , <i>roll</i> , <i>chop</i> and <i>cover</i> .	
			The child was then asked to retell the story orally without support from the TA (the TA transcribed). The TA was able to provide support with general prompting with questions such as "what happened at the beginning of the story" and "what happened here?".	This used imitation but was also a record of progress over the 10 weeks
			The child was then supported to write the story using the RSPT. They were required to write one sentence under each of the four pictures. The sentence had to be written using the RSPT and the TA was directed to provide as much scaffolding as required to achieve this. The ideas and length of the sentence should be led by the child, but the target verb had to be used in the RSPT and the sentence had to be grammatically correct.	Use of orthography to support Modelling and imitation (if required)
			When writing the verb, the child was given the root verb to copy and then asked what they needed to add to make it a finished verb. The children who were unable to write used cut up sentences, words and letters	Explicit teaching of grammatical rules
	Verb review	3	The verb introduction activity is repeated (see Monday)	Intensity
	Acting out task	14	The child was videoed acting out the four verbs of the week in a functional sequence. These activities were linked to the story used on Monday e.g. the story 'The Pizza' showed a boy making a pizza, the child was asked to make a pizza with playdoh acting out the four verbs <i>squeeze</i> , <i>roll</i> , <i>chop</i> and <i>cover</i> . Activities included a puppet show, growing a plant, and role play of the story from Monday.	Linking to own experience Linking to context
			As the child acted out each verb, the TA videoed and described what was happening e.g. "(child's name) is squeezing the playdoh". After approximately 30 seconds, the TA said "stop" and described what had happened using the RSPT, before stopping the recording e.g. "(child's name) squeezed the playdoh". Thus, creating four short videos the child could watch and hear the appropriate tense being used both when the action was happening and after it had finished.	Modelling Linking to own experience Linking to context
Tuesday			The child then watched each video back and at the end of each one, they wrote what they had done using the RSPT e.g. "I squeezed the playdoh". For those children who were unable to write, cut up sentences, words and letters were provided. The TA supported the writing by providing the root verb and using the <i>finished</i> label. They asked questions about the use of the grammatical morpheme - ed. To further embed the rule e.g., "what do we need to add to the verb to tell us that it's finished?" and "why have you added -ed?"	Modelling Use of orthography to support Linking to own experience Linking to context Explicit teaching of grammatical rules

	Story review	3	The child was asked to retell the story they wrote on Monday reading the sentences they had written the day before. If the child was unable to read the sentence, the TA modelled the sentence for the child to repeat.	Intensity Modelling Use of orthography to support Linking to own experience Linking to context		
	Verb review	3	The verb introduction activity is repeated (see Monday)	Intensity		
	Introduce time word	4	On week one, the child was introduced to the word card <i>yesterday</i> . They were told that <i>yesterday</i> is a <i>finished</i> word and were supported to put the word card in the finished column of the table.	Modelling and imitation Use of orthography to support		
			The child then watched the videos from the previous day. After each action was watched, the TA asked "what did you do yesterday?" and the child was supported to place the finished action picture cards on the finished side of the table (under the word yesterday). As they place each one, the TA modelled the sentence "yesterday I jumped" for the child to repeat.	Linking to own experience Linking to context Use of orthography to support Modelling and imitation		
Wednesday	Look back activity sheet	10	The child was then given a sheet/template and asked to write about what they did yesterday (which they had just reviewed in the videos). One example was a large postcard and the child might write 'Dear Mum. Yesterday I squeezed playdoh' etc. The child was supported to write while the TA asked questions about the use of the grammatical morpheme <i>-ed.</i>	Use of orthography to support Explicit teaching of grammatical rules Modelling and imitation (if required) Linking to own experience Linking to context		
			N.B. when the child was confident using <i>yesterday</i> the TA moved on to introduce the word <i>last</i> and then questions including "what has (the person) done?" and "what is the person doing?".			
	Story review	3	The child was asked to retell the story they wrote on Monday. If required, the TA modelled for the child to repeat.	Intensity Modelling Use of orthography to support Linking to own experience Linking to context		
	Verb review	3	The verb introduction activity was repeated (see Monday)	Intensity		
Thursday	Review time word activity	10	The child looked back at the work from the week. The TA asked what they had done each day and the child was encouraged to read back/retell each activity. The TA modelled and asked the child to repeat as necessary.	Intensity Linking to own experience Linking to context		
T	Verb games	7	Two games were played using the verbs for the week as well as any verbs covered in previous weeks. These games included barrier games, pairs, snap, charades	Frequency of modelling Multiple repetitions		

			and used the RSPT and the present continuous tense action cards. The TA modelled and encouraged the child to repeat if the child incorrectly described the card. For example, in charades the child and TA took it in turns to choose one picture and then mime the action. For the RSPT cards, the action was mimed and then the person said "stop" before the other person guessed. In another example, the child and TA took it in turns to play pairs. All pictures were laid face down on the desk and the aim was to find the verb pairs (one <i>is happening</i> picture and one <i>finished</i> picture for the same verb. When each picture was turned over, the child was required to describe the picture using the picture and words. If the child was incorrect, the TA modelled the correct sentence and asked the child to repeat.	Use of orthography to support Modelling and imitation
ay	Consolidation	20	The work from the week was reviewed and placed into a record book. The child was encouraged to read back/retell each activity.	Frequency of modelling Use of orthography to support Multiple repetitions
Friday			Two activities/games from any week covered so far were selected to repeat	Frequency of modelling Multiple repetitions Use of orthography to support

7.4.3. Speech and language therapist visits

During this visit, the SLT observed and video recorded the TA delivering the daily session. Following the session, the SLT provided some feedback and discussed any questions and/or problems the TA was experiencing. As part of the observation the SLT scored the TA on a scale of one to four regarding the following five criteria:

- 1. Organisation: preparation, familiarity, time management.
- 2. Tailoring to individual needs: whether the activity was too easy/difficult for the child and whether the TA provided enough/too much/too little support.
- 3. Compliance: whether all activities were completed and how closely the TA complied with the instructions and techniques.
- 4. Behaviour: how the TA managed the child's behaviour.
- 5. Enjoyment: how engaged and positively the child responded to the activities.

This rating scale was adapted from a previous study used to assess fidelity of implementation and effectiveness (Burgoyne et al., 2012a). The full scoring scale can be found in in Table 10. A copy of the TA observation sheet is in Appendix I.

Table 10 TA scoring criteria
The table shows the TA scoring criteria used in SLT observations

Factor	Score						
	1	Lots of time spent looking up what to do, resources not ready,					
<u>_</u>		activities not to time					
atic	2	Some time spent looking up activities, resources party ready,					
is.	_	activities not to time					
Organisation	3	Generally knows the activities for the day, most resources ready, most activities to time					
	4	Session flows, activities known and resources ready, timings					
		adhered to					
	1	Activities are far too difficult or easy for the child, Too much/little					
မြို့		support, TA doing most of the work					
Tailoring to individual needs	2	Some activities are pitched at an appropriate level, too much/little					
i i k		support in some activities, TA doing half or more of the work					
<u> </u>	3	Activities are generally pitched at an appropriate level, too					
Ţä. <u>≼</u> i		much/little support in some activities, TA doing 25% of the work					
i.	4	Activities at an appropriate level, appropriate amount of support,					
		child doing most of the work					
<u>a</u>	1	Some activities not completed, not using finished and is					
mpli nce		happening, activities not to guide					
Complia	2	Some activities not completed, some use of targets strategies,					
O		some activities to guide					

	3	All activities completed, using target phrases and some					
		questioning/target prompts, activities generally to guide					
	4	All activities completed to guide, target phrases used and good					
		use of questioning/prompts to support the child					
	1	Child refusing – Not using clear instructions, lots of					
ent		discussion/distraction, over timings/activities not completed and					
Ĕ		no use of timetable or reward system					
Behaviour management	2	Child showing some refusals – using some clear instructions but					
ans		too much discussion/distraction from task, over timings but					
Ĕ		activities generally completed – some use of timetable and					
בַּ		reward system.					
<u>.</u>	3	Child generally on task – some unclear instructions/lack of clarity					
ha		and discussion, timings adhered to, behaviour supports used					
Be	4	Child on task, all activities clear and prepared, timings adhered					
		to, behaviour supports used or not required.					
	1	Child not engaged in task, refusing					
s ent	2	Some engagement in task and smiling, some refusals					
Child's enjoyment	3	Generally engaged in task and smiling during tasks, some					
		positive language about the task used					
e C	4	Child keen to complete the intervention activities, smiling and					
		engaged, using positive language about the activity.					

8. Results

8.1. Before intervention

At t1 a series of baseline measures were completed to allow comparison of the intervention group and the delayed intervention group. Table 11 shows the descriptive statistics for each group on the baseline measures administered at t1 only. The data in at the beginning of this chapter (8.1 and 8.2) have been published in a recent journal article as per the impact statement at the beginning of this thesis (Baxter et al., 2022).

Table 11 Baseline measures completed at t1 only

<u>The table shows the mean raw scores (standard deviations) on all baseline measu</u>res completed at t1.

Intervention Group

			Delay		
	Interve	ention	interve	ntion	
	n =	26	<u> </u>	26	_
	Μ	SD	М	SD	
Age (months)					
t1	106.00	15.73	108.81	16.0 8	
t2	110.50	15.79	114.50	15.7 7	
t3	113.32	16.08	117.54	15.8 7	
Baseline assessments	(t1)				
Raven's CPM	13.73	3.77	12.12	2.79	
ROWPVT	60.23	9.44	62.15	10.1 5	
EOWPVT	53.69	13.33	54.69	12.2 2	
TROG-2	19.69	10.88	19.5	7.91	
CELF-4 RS	3.23	5.32	2.85	3.86	
TEGI Phon. Probe	19	2.59	17.38	5.3	
YARC Word reading	19.31	12.20	18.62	10.8 4	
YARC LSK	13.5	4.44	13.15	4.53	

Abbreviations: Raven's CPM, coloured progressive matrices; ROWPVT, receptive one-word picture vocabulary test; EOWPVT, expressive one-word picture vocabulary test; TROG-2, test for reception of grammar; CELF-4 RS, clinical evaluation of language fundamentals recalling sentences; Phon, phonological; YARC, York assessment of reading comprehension; LSK, letter sound knowledge.

In addition, all children completed the Intervention Test Battery. The battery was designed specifically to measure any progress made after the PaTI on the use of the RSPT and related factors. The battery included two published assessments and a number of bespoke measures and were completed at all time points. Table 12 shows the descriptive statistics for each group on the published assessments at the three time points: pre-intervention (t1), immediately after the intervention group had received the 10 weeks intervention (t2) and approximately 14 weeks later when the delayed intervention group had received the intervention and the intervention group had returned to "business as usual" (t3).

Table 12 Intervention test battery – published assessments administered at all time points
The table shows the mean raw scores (standard deviations) on the published assessments administered at all
time points in the study, t1 prior to intervention, t2 post intervention and t3 follow up. The effect size at each time
point is calculated as the difference between groups divided by the pooled standard deviation at that time point
(Cohen's d), a positive value of d indicates an advantage for the Intervention group compared to the Delayed
Intervention group. 95% confidence intervals are given for each value of d; where the confidence interval does
not include zero the difference is significant (indicated by*)

Intervention Group

		_	Dela				
	Interve		interve		Cohen's d		
	n =	n = 26		26			
	М	SD	М	SD			
Renfrew Action Pictur	e Test (RAPT)					
RAPT Grammar							
t1	8.5	5.68	10.27	6.70	28 [83, .26]		
t2	13.17	6.53	11.69	5.88	.24 [31, .78]		
t3	15.24	6.76	12.71	6.98	.37 [19, .92]		
RAPT Information							
t1	21.63	6.59	21.73	5.98	02 [56, .53]		
t2	24.06	4.99	23.79	5.26	.05 [49, .60]		
t3	26.66	5.80	26.79	4.57	02 [57, .52]		
Test of Early Gramma	atical Impairme	ent (TEGI)					
TEGI Past Tense Pro	be – regular v	erbs					
t1	1	2.21	1.27	1.82	13 [68, .41]		
t2	7.12	3.15	1.12	1.70	2.37 [1.65, 3.07]*		
t3	7.08	3.91	7.04	3.68	.01 [54, .56]		
TEGI Past Tense Pro	be – irregular	verbs					
t1	0.42	0.64	0.27	0.53	.26 [29, .81]		
t2	0.35	0.69	0.35	0.63	0 [54, .54]		
t3	0.48	0.92	0.24	0.52	.32 [24, .88]		
TEGI Past Tense Pro	be – overregu	larisation e	rrors				
t1	0.08	0.27	0.27	0.83	31 [86, 2.06]		
t2	3.69	2.90	0.5	1.14	1.45 [.83, 2.05]*		
t3	3.92	2.63	3.6	2.29	.13 [43, .68]		
TEGI Third Person Si	ngular Probe				- -		
t1	0.92	2.13	0.81	1.52	.06 [48, .61]		
t2	0.88	2.14	0.92	1.44	02 [56, .52]		
t3	1.64	2.80	1.24	1.69	.17 [38, .73]		

Data for one child are missing for t3 on all intervention measures in the Intervention Group, and for one child on t3 TEGI probes in the Delayed Intervention group.

Note: overregularisation errors, when the regular rule is applied to irregular verbs (e.g., digged).

The bespoke measures were designed specifically for this project (see Chapter 7) to attempt to capture any small gains in the use of the RSPT and to measure its use in a more natural language sample, story retell. Table 13 shows the descriptive statistics for each group on the bespoke measures at the three time points.

Table 13 Intervention test battery - bespoke measures administered at all time points
The table shows the mean raw scores (standard deviations) on the bespoke measures administered at all time
points in the study, t1 prior to intervention, t2 post intervention and t3 follow up. The effect size at each time point
is calculated as the difference between groups divided by the pooled standard deviation at that time point
(Cohen's d), a positive value of d indicates an advantage for the Intervention group compared to the Delayed
Intervention group. 95% confidence intervals are given for each value of d; where the confidence interval does
not include zero the difference is significant (indicated by*)

Intervention Group

				ayed	
		ention		ention	Cohen's d
		: 26	n = 26		
	М	SD	М	SD	
Bespoke Regular Sim	iple Past Ten	se Probes (RSPTP)		
Taught RSPTP					
t1	4.73	7.37	4.62	7.10	.02 [53, .56]
t2	30.23	11.16	4.12	7.15	2.79 [2.01, 3.55]*
t3	28.6	13.63	28.19	13.48	.03 [52, .58]
Untaught RSPTP					
t1	2.5	3.15	2.35	3.19	.05 [50, .59]
t2	12.81	6.53	2.23	3.56	2.01 [1.33, 2.68]*
t3	13.44	7.23	12.69	6.32	.11 [44, .66]
RSPT Sentence Repe	etition				
t1	17.62	6.79	15.96	7.64	.23 [32, .77]
t2	24.04	5.92	17.08	7.21	1.06 [.47, 1.63]*
t3	23.36	6.85	21.5	7.66	.26 [30, .81]
Narrative Retell					
Retell TNW					
t1	43.42	20.00	40.27	16.36	.17 [37, .72]
t2	51.27	21.16	49.62	22.31	.08 [47, .62]
t3	52.6	21.66	54.12	25.47	06 [61, .48]
Retell NDW					-
t1	27.35	10.31	25.96	9.07	.14 [40, .69]
t2	30.31	10.19	30.38	10.81	01 [55, .54]
t3	31.76	10.68	32.04	11.41	03 [57 .52]
Retell MLU					-
t1	3.76	1.46	3.91	1.59	08 [62, .46]
t2	4.46	1.75	4.13	1.63	.20 [35, .74]
t3	4.45	1.68	4.38	1.59	.04 [51, .59]
Retell Past Tense					
t1	0.81	1.36	0.62	0.90	.17 [38, .71]
t2	3.65	2.35	1.27	1.34	1.25 [.65, 1.84]*
t3	3.72	2.61	3.62	2.70	.04 [51, .51]

Abbreviations: MLU, mean length of utterance; NDW, number of different words; RSPT, regular simple past tense (sentence repetition); TNW, total number of words.

Data for one child are missing for t3 on all intervention measures in the Intervention Group.

The two groups were allocated randomly and performed similarly on baseline and intervention measures at t1. The children had particularly low scores on the baseline measures of nonverbal mental age (Raven's CPM), receptive language (TROG-2) and expressive language (CELF-4 RS). The median standard score on the nonverbal mental age measure was <60, with 37 out of the 52 children receiving this score. The raw scores are presented due to these low scores as is typical of the literature on individuals with DS. The mean standard score on the receptive grammar measure (TROG-2) was 55.48 (95% CI 54.94, 56.20). The mean standard scores were better

on measures of receptive vocabulary (ROWPVT) 73.85 (95% CI72.03, 75.66) and expressive vocabulary (EOWPVT) 71.32 (95% CI 67.95, 73.44). The receptive and expressive vocabulary measures did not differ significantly from each other (t = 1.92, d.f. = 102; p = 0.06). The expressive language measures reveal the substantial difficulties the children have in this area with children frequently scoring at floor on the baseline measure (CELF-4 SR 26.92%). The remaining 73.1% of participants' raw scores ranged from 1-26 with a mean raw score of 3.0. In addition, the specific difficulties with morphosyntax are revealed by the high percentages of children scoring at floor on the standardised intervention test battery measure (TEGI: regular past tense 63.46%, irregular past tense 71.15%, third person singular 71.15%). This profile of relative strength in vocabulary compared to grammar is typical of individuals with DS (Laws 1998; Laws et al., 2003; Laws & Gunn 2004; Næss et al., 2015; Rosin et al., 1988). The large standard deviations observed in both groups reflects the range of individual differences also commonly reported for individuals with DS (e.g., Fowler, 1990; Rondal, 1995).

8.2. Intervention effects

The aim of the study was to evaluate an intervention targeting the use of the RSPT in children with DS. As expected, given randomisation, the two groups do not differ reliably on any of the measures pre-intervention (Cohen's d's ranged from -0.26 to 0.31). Tables 12 and 13 shows improvements for the intervention group over the delayed intervention group at t2 on a number of the language measures although effect sizes differ.

To evaluate whether the intervention had any effects on the children's use of the RSPT, four different measures were used to develop a composite measure. This RSPT composite measure was used to simplify analysis and increase the reliability of the measure. The four tests that measured the use of the RSPT were: 1) the Bespoke Taught Regular Simple Past Tense Probe (TRSPTP) which measured any gains on the verbs explicitly taught during the 10 week intervention block, 2) the Bespoke Untaught Regular Simple Past Tense Probe) which measured any gains generalised to items not taught during the intervention, 3) the past tense probe from the Test of

Early Grammatical Impairment (TEGI) which measured the use of the targeted morpheme and 4) the Bespoke Narrative Retell task which measured any gains in a more natural narrative language sample. The narrative retell was scored for the use of nine examples of the regular past and this score was included in the tense composite (the narrative retell was also scored for total number of words, number of different words and MLU which were analysed separately). These four measures of RSPT use correlated uniformly and highly at t2 and t3 (r_s 0.76-0.97 at t2; r_s 0.79-0.96 at t3) and moderately to strongly at t1 (r_s 0.49-0.86). A composite score was therefore created by averaging the scores of these four measures to determine whether any gains had been made on use of the RSPT, targeted by the intervention. This measure is referred to as the Total past tense score.

The critical comparison to evaluate the effect of the intervention is the difference between groups at t2 (after the intervention group has received the intervention but before the delayed intervention group has received it). The effects of the intervention were assessed using regression (ANCOVA) models with baseline performance on the same variable as the covariate. Figure 2 shows the differences between the groups' marginal means, with 95% confidence intervals. Positive values indicate greater gains in the intervention compared to the control group. These gains are statistically significant (p < .05) where the 95% confidence intervals do not cross the x-axis.

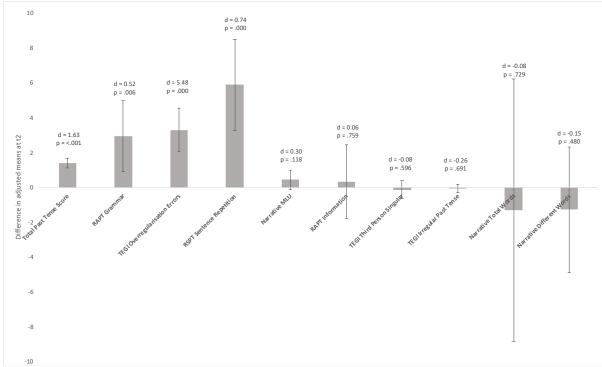


Figure 8 Comparison of the intervention group and the delayed intervention group at t2
The figure shows the differences between the marginal means for the intervention and delayed intervention
groups at t2 (controlling for the same measure at t1) on intervention outcome measures with 95% confidence
intervals, effect sizes (d, difference in raw score gains divided by pooled SD at t1) and p-values. RSPT, Regular
simple past tense; RAPT, Renfrew Action Picture Test; TEGI, Test of Early Grammatical Impairment; MLU, mean
length of utterance

The intervention group made significantly greater gains than the delayed intervention group on the Total past tense score (composite score), the RAPT grammar, TEGI errors of overregularisation, RSPT Sentence repetition. These gains are all significant after applying a conservative Bonferroni correction (p < 0.005). These effect sizes should be interpreted with some caution as many of the children scored at floor on these measures at t1. These low scores may inflate the effect sizes but are typical given the difficulties with morphosyntax for individuals with DS.

The RSPT Sentence Repetition was not included in the tense composite as sentence repetition was not considered a measure of the child's use of the RSPT, rather gains may be expected to be achieved through simple repetition practice. Therefore, gains on this measure were excluded from the composite score as to ensure scores of RSPT use were not inflated.

No significant gains were observed on the remaining measures including RAPT information or the other measures on the narrative retell (i.e., total number of words,

number of different words, MLU). Similarly, no significant gains were observed on the other measures of tense; the irregular past or the third person singular -s.

The gains seen on the use of regular past tense on the TEGI at t2 were large (d=2.37) in favour of the intervention group. The bespoke narrative language task, constructed to elicit story retell as a measure of more spontaneous language, also showed large gains for the use of the regular past tense in favour of the intervention group (d=1.25).

The generalisation to the untaught verbs is evidence that the children have learnt the RSPT rule as they have been able to mark tense on these untaught items (d=2.01). However, perhaps more convincing evidence of this conclusion is the significant gains in the TEGI errors of overregularrisation (d=1.45). Only 15/52 children produced an overregularised error at t1 (range 1-2). Here the children have marked an irregular verb with the regular past tense -ed (e.g., eated \rightarrow /iːtɪd/), suggesting that they are extracting and applying a grammatical rule.

No generalisation was observed to other tense morphemes, such as irregular simple past tense verbs (TEGI d=0) or third person singular -s (TEGI d=0.02). These other tense morphemes were not included in the intervention and are not directly related to the regular past tense (i.e., they require different morphemes).

8.2.1. Individual differences

Given the literature reviewed and the wide range of individual differences reported for individuals with DS, the t2 results were explored for differences between the children in the size of gains made in response to the intervention. The Total past tense score was used to plot the pretest vs posttest scores for both groups shown in Figure 9.

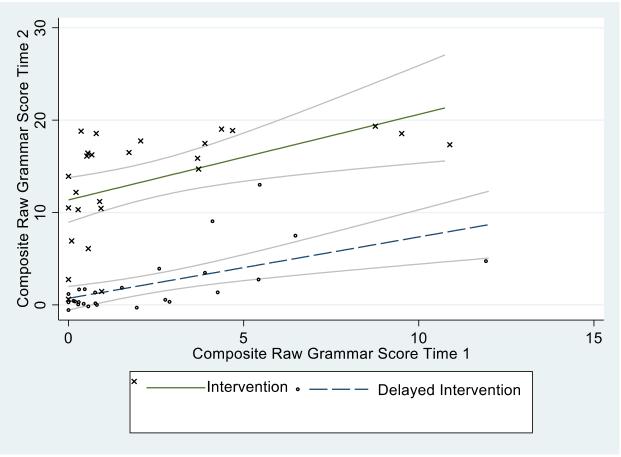


Figure 9 Scatterplot showing individual differences at t2
The figure shows the Total past tense scores for the two groups using four measures of regular simple past tense marking at time 1 (before intervention) and time 2 (immediately after intervention for the Intervention group). The solid lines are the regression functions relating time 1 to time 2 scores for the two groups. The dashed lines indicate the 95% confidence intervals for the predicted means for each group

Regression analysis shows the relationship between the scores at t1 and t2 for both groups. Figure 9 also shows the regression functions for both groups are parallel which shows that children with the lowest scores at t1 make roughly equivalent gains to those with higher pretest scores, although it should be noted that the majority of children had very low scores at t1. More importantly it shows that the intervention was not effective for five of the 26 children in the intervention group. These children were amongst those with the lowest scores at t1. However, some other children with similarly low scores at t1 made large improvements in their scores at t2.

8.2.2. Intervention measures at time 3

At t3, the delayed intervention group had received the intervention, whereas the original intervention group had returned to "business as usual". Tables 12 and 13 shows that the delayed intervention group made similar gains at t3, once they had received the intervention.

The total past tense score was calculated for the delayed intervention group in a similar way to the intervention group; a composite measure of RSPT (average from the TEGI regular verbs, the bespoke TRSPTP, the bespoke URSPTP and the use of the past tense in the narrative retell) was calculated. The gains for the initial intervention group were calculated as the difference between these scores from t1 to t2 scores (after they had just received the intervention). The intervention gains for the delayed Intervention group were calculated as the difference between the t2 and t3 scores (after they had just received the intervention). As the data on the TEGI following intervention is missing for one child, this child is excluded from analysis. Figure 10 shows the Total past tense scores at all three timepoints.

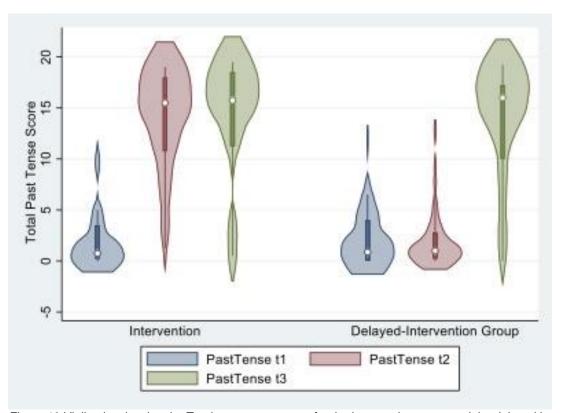


Figure 10 Violin plot showing the Total past tense scores for the intervention group and the delayed intervention group at all timepoints

The figure shows Total past tense scores using four measures of regular simple past tense marking as a function of time and group. The hollow circle at each time point indicates the median value, the dense bar represents the interquartile range, and the spikes represent the upper and lower adjacent values

At t1, both groups score poorly on the use of regular past tense, many at floor. At t2, the intervention group have made significant gains, whilst the delayed intervention group's scores remain very low. At t3 the delayed intervention group have made similar gains to those made by the intervention group at t2 (once they had received the intervention group). Furthermore, the intervention group (who have returned to

"business as usual" and not continued to receive intervention) have maintained the gains achieved at t2 12-14 weeks later.

8.3. Factors influencing intervention

Following the analysis of the intervention effects, a number of factors associated with the intervention were explored. These factors included the baseline measures, the number of sessions the child received and the delivery of the intervention. The relationship between these factors and the gains made on the intervention was explored using correlation analysis.

8.3.1. Time 1 measures

The relationship between the intervention gains and a selection of t1 measures was investigated as well as any relationships between the different t1 measures. Tables 10-12 shows the scores at t1 on these measures are variable with many children gaining particularly low scores on the expressive language measures (e.g., TEGI, CELF). These scores were not normally distributed and therefore were analysed using Spearman's rank correlation. The Spearman's Rank correlation showed correlations between the remaining measures and the intervention gain for 51 participants (after all children had received the intervention) and are shown in Table 14.

Table 14 Correlation among assessment measures
The table shows the correlation among the baseline measures and the total past tense score

	1	2	3	4	5	6	7	8	9	10	11
1. Age	-	-0.077	-0.054	0.005	0.017	0.174	0.156	0.074	-0.162	0.042	-0.166
2. YARC WR	0.056	-	0.832**	0.283*	0.493**	0.353*	0.430**	0.503**	0.624**	0.532**	0.469**
3. YARC LSK	0.087	0.648**	-	0.234	0.470**	0.336*	0.302*	0.467**	0.491**	0.493**	0.368**
4. TROG-II	0.123	0.169	0.178	-	0.621**	0.583**	0.549**	0.457**	0.457**	0.245	0.386**
5. RAPT Grammar	0.136	0.385**	0.381**	0.496**	-	0.797**	0.537**	0.587**	0.719**	0.401**	0.495**
6. RAPT Info	0.357**	0.27	0.366**	0.447**	0.674**	-	0.562**	0.558**	0.525**	0.516**	0.511**
7. ROWVT	0.271	0.428**	0.278*	0.507**	0.438**	0.465**	-	0.591**	0.567**	0.388**	0.323*
8. EOWVT	0.162	0.38**	0.457**	0.398**	0.493**	0.424**	0.541**	-	0.507**	0.327*	0.352*
9. CELF SR	0.004	0.303*	0.147	0.488**	0.533**	0.195	0.519**	0.521**	-	0.336*	0.499**
10. Total PTS	0.18	0.549**	0.642**	0.076	0.242	0.474**	0.29*	0.233	-0.057	-	0.414**
11. NVMA	-	-	-	-	-	-	-	-	-	-	-

^{**}p < 0.01

Partial correlations controlling for age are below the diagonal and simple correlations are above the diagonal.

Abbreviations: Raven's CPM, coloured progressive matrices; ROWPVT, receptive one-word picture vocabulary test; TRGOG-II, test for reception of grammar; CELF-4 RS, clinical evaluation of language fundamentals recalling sentences; YARC, York assessment of reading comprehension; WR, word reading, LSK, letter sound knowledge; Total PTS; Total past tense score. N51.

^{*}p < 0.05

Gains following intervention were significantly correlated with all measures with the exception of chronological age ($r_s = 0.042$, p = 0.767) and receptive grammar (TROG-2) ($r_s = 0.245$, p = 0.08). The measure of nonverbal mental age (Raven's) was significantly correlated with all other measures as shown in Table 14. After controlling for nonverbal mental age (to determine the role of nonverbal mental age), receptive vocabulary ($r_s = 0.2.90$, p = 0.039), RAPT information ($r_s = 0.474$, p = <0.001), word reading ($r_s = 0.549$), p = <0.00.) and letter sound knowledge ($r_s = 0.642$, p = <0.001) remained significantly correlated with gains on the use of RSPT.

8.3.2. Number of intervention sessions

The TAs were required to keep a record of the number of sessions they had completed. Completed records were not returned for only five participants (three of the intervention group and two of the delayed intervention group). The majority of the children received a high number of the 50 possible intervention sessions: intervention group mean 41.30 (SD 8.22), delayed intervention group mean 42.08 (SD 9.19).

The number of sessions were compared to the Intervention gain for all participants to see whether the number of sessions received was related to any gains. These scores were not normally distributed and therefore were analysed using Spearman's rank correlation. Given the high number of sessions, as might be expected, no significant correlation was found between number of sessions received and the intervention gains for all participants ($r_s = 0.230$, p = 0.120).

8.3.3. Quality of intervention delivery

In addition to the training day and the manual that included detailed instructions, the TAs were visited by the SLT researcher approximately every two weeks during the 10-week intervention. Each visit included observation with feedback, support and direction from the SLT. In addition, the observed sessions were rated on a scale of 1-4 on different areas of intervention delivery: 1) organisation, which included adhering to timings, having resources ready, knowledge of the session plan, 2) tailoring to individual's needs, which included providing too little/too much support, ensuring the child was actively involved in the activity, 3) Compliance, how closely the TA was

adhering to the intervention e.g., delivering the correct activities, using the intervention language, 4) behaviour management, how well the child was supported to complete activities, 5) enjoyment, how much the child was engaged in the session. Rating criteria can be found in Chapter 7 (7.4.3). Whilst five observation visits were booked for all 52 children, nine children only received four visits due to the child not being in school (e.g., holiday, illness, school closure).

In order to determine whether TAs' delivery of the intervention improved, scores from the first observation session (within weeks 1-2 of the intervention block) and the last observation session (within weeks 9-10 of the intervention block) were compared. The TA scores for areas 1-4 were summed and compared to the intervention gain for all participants using a Wilcoxon signed-rank text. The Wilcoxon signed-ranks test revealed that the TA scores from the last two weeks of the intervention were significantly higher than those from the first two weeks after applying a conservative Bonferroni correction (z = -4.126, p = <0.002). Figure 11 shows the ranges in scores.

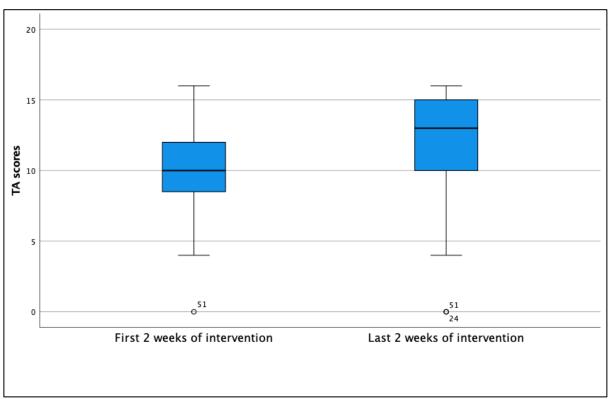


Figure 11 Box plot showing the TA scores as a function of time TA scores from the first two weeks of the intervention compared to the last two weeks of the intervention (N51)

An overall average mean score was calculated for each TA. Firstly, a mean average for each of the areas 1-4 was calculated and then an overall average was calculated

from these scores. This TA score provided a general delivery score for each TA (the fifth area (engagement of the child) was analysed separately as a reflection of the child rather than the TA delivery).

The relationship between the TA score and the intervention gain for all participants was explored. These scores were not normally distributed and therefore were analysed using Spearman's rank correlation. The Spearman's Rank correlation showed that there was a significant correlation between TA mean scores and the intervention gains for all participants after applying a conservative Bonferroni correction ($r_s = r = 0.627$, p = <.001). Figure 12 illustrates a generally linear positive relationship between these two variables.

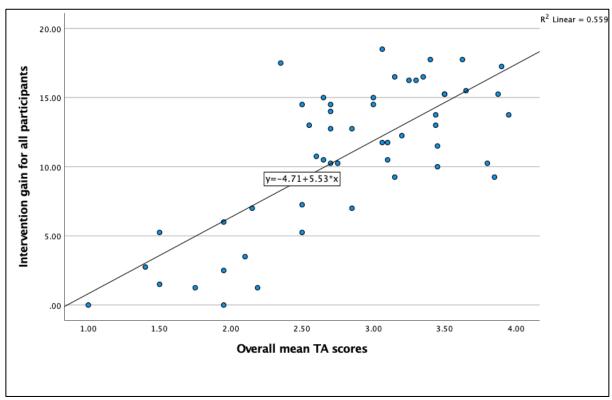


Figure 12 Scatter plot showing the relationship between the overall TA scores and the intervention gains for all participants (intervention group gains at t2-t1, delayed intervention gains t3-t2)

The relationship between the child's enjoyment score and the intervention gains for all participants was also explored using Spearman's Rank correlation. This analysis showed that there was a significant correlation between child enjoyment score and the intervention gains for all participants after applying a conservative Bonferroni correction ($r_s = r = 0.592$, p = <.001). Figure 13 illustrates a generally linear positive relationship between these two variables.

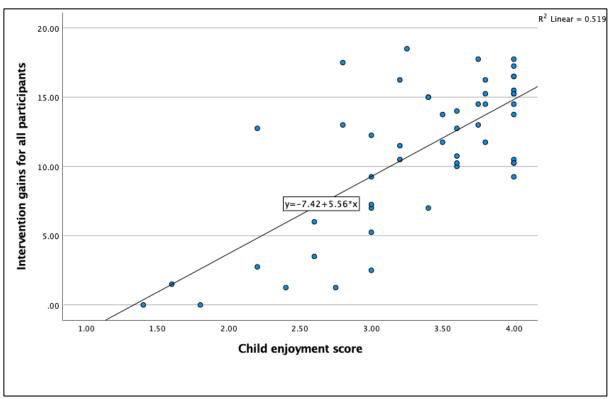


Figure 13 Scatter plot showing the relationship between the overall TA scores and the intervention gains for all participants (intervention group gains at t2-t1, delayed intervention gains t3-t2).

8.3.3.1. Teaching assistant feedback

The PaTI intervention was developed for this study and therefore had not been delivered previously. At the final assessment session (t3), TAs were given a questionnaire to complete to gather their feedback. The questionnaire included the experience of the TA, feedback about delivering the intervention and the intervention activities. A total of 24 TAs returned questionnaires (46.15%) and this information is summarised below.

TA previous experience

The first section gained basic information regarding the TAs' experience of working with a pupil with DS. Out of the 24 responses, 87.5% reported that this was the first pupil with DS they had supported. The mean length of time working with the pupil receiving the intervention was 3.6 years (range 10 weeks to 7 years).

TA rating of intervention and training

TAs were asked to rate their experience on a seven-point rating scale (1 = not at all, 7 = very much) on the following 7 questions at the end of the project (t3)

- 1. How confident did you feel about being able to deliver the intervention?
- 2. How much did you enjoy delivering the intervention?
- 3. How much do you think the child you supported enjoyed participating in the intervention?
- 4. How much did you think the training prepared you to deliver the intervention?
- 5. How much do you think the manual supported you to deliver the intervention?
- 6. How well do you think the intervention adaptations met the needs of the child (e.g., levels 1-4, sentences/words for non-writers etc)?
- 7. How clear and engaging did you the find the resources?

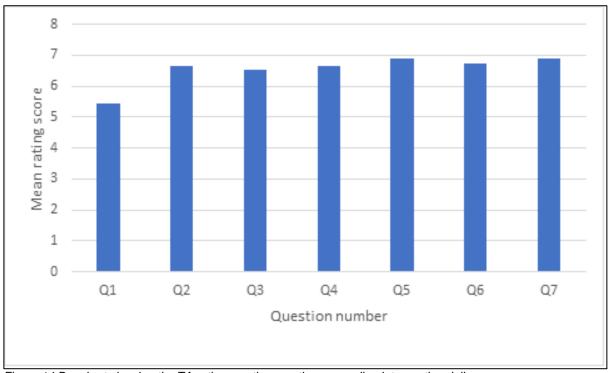


Figure 14 Bar chart showing the TA ratings on the questions regarding intervention delivery (Ratings were reported via a questionnaire following the end of the intervention, t3) (N24)

Overall, the TAs responded positively to delivering the intervention with a mean score of 5.45 (range 2-7) regarding confidence in delivery. They rated the training (mean 6.64, range 6-7) and the manual (6.91, range 6-7) highly in terms of being prepared and supported to deliver the intervention.

TA rating of children's response to activities

The TAs were asked to feedback on the core activities included in the intervention regarding; which activities the child enjoyed most/least and which activities encouraged the child to use the target structures most/least (the RSPT and the contrasted present progressive). A percentage of the total number of activities reported for each question is shown in Figure 15.

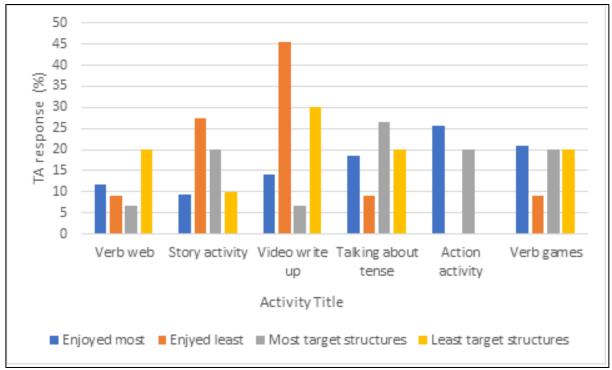


Figure 15 Bar chart showing the TA feedback responses on the intervention activities (Responses were reported via a questionnaire following the end of the intervention, t3) (N24)

TAs selected more activities in response to most enjoyed (total activities selected = 86) compared to fewer activities least enjoyed (total activities reported by the 24 TAs = 22). Two TAs wrote "none" in response to the child's least favourite activity. The action activity was selected most enjoyed by the child (selected by 22/24 TAs). This activity involved the child acting out the target verbs for the week, whilst the TA videoed. The least favourite activity selected was the video write up (selected by 10/24 TAs).

8.3.4. Phonological and linguistic factors

As discussed in Chapter 3 (3.1) there are a number of factors associated with the acquisition of morphemes including linguistic and phonological factors. The t3 results were explored to see if there were any differences in the verbs marked for tense in terms of 1) phonological form and 2) expected order of verb acquisition.

Phonological form: The RSPT morpheme -ed can take one of three forms; 1) the addition of /d/ when the verb stem ends is a vowel (e.g., cried /krʌɪd/, stirred /stəːd/), 2) the addition of the syllable /ɪd/ when the verb ends in the alveolar plosives /t/ or /d/ (e.g., waited /weɪtɪd/, planted /plɑːntɪd/) and 3) the addition of /t/ or /d/ to form a cluster (e.g., washed /wpʃt/, hugged /hʌgd/). The verbs selected for the bespoke TRSPTP (taught regular simple past tense probe) and those selected for the bespoke URSPTP (untaught regular simple past tense probe) included the various phonological forms of regular past tense -ed: /d/, /ɪd/ and cluster. In addition, the verbs were selected from three vocabulary checklists which chart the expected order of verb acquisition (i.e., the first verbs typically produced are on checklist one and so on).

The 40 verbs from the TRSPTP and the 20 verbs from the URSPTP were all coded for phonological form (e.g., /d/, /ɪd/ or cluster). The number of children who successfully marked the RSPT on each of these 60 verbs at t3 (once all children had received the intervention) was calculated.

A one-way ANOVA was performed to compare the effect of phonological form on the t3 raw scores. A statistically significant difference was found between two groups (F (2, 57 = [18.014], p = <0.001)). Tukey's HSD Test for multiple comparisons found that the mean value of time 3 raw scores was significantly different between the /d/ form and the /Id/ form (p = <0.001, 95% C.I. = [5.70, 14.12]) and the cluster formation and the /Id/ form (p = <0.001, 95% C.I. = [4.30, 11.31]). There was no significant difference between the /d/ form and the cluster formation (p=0.235). Figure 16 shows the range in scores.

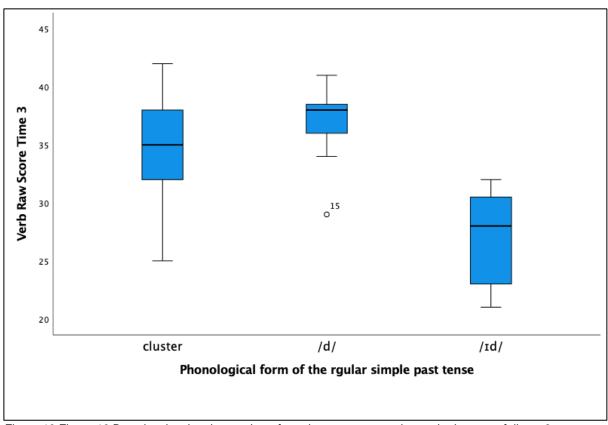


Figure 16 Figure 16 Box plot showing the number of regular past tense verbs marked successfully at t3 as a function of group (after all children had received the intervention) as a function of group (N51)

8.4. Difficulties with morphosyntax

This study gathered one of the largest samples of data (with 52 participants) on the use of past tense in children with DS. Furthermore, the participant age range is relatively narrow with children from 7-11 years. Given the previous limited, small-scale studies with large age ranges, this study provided a further opportunity to examine some of the difficulties with morphosyntax of 52 children with DS aged seven to 11 years preintervention (t1).

8.4.1. Tense vs non-tense morphemes

To explore whether children with DS have more difficulties with tense vs non-tense morphology, data on the use of regular plurals from the Renfrew Action Picture Test (RAPT) was compared with data on the use of the RSPT from the Test of Grammatical Impairment (TEGI). It was not possible to compare the use of these morphemes from the same measure, due to the lack of obligatory contexts for the RSPT in the RAPT and lack of obligatory contexts for regular plurals in the TEGI. Obligatory context has

been defined as being determined either by the discourse context (the context calls for the use of a particular structure) or the utterance structure requiring the use of a specific structure (Pierce et al., 2013).

Analysis of the RAPT

The RAPT elicits a number of grammatical morphemes and the children's responses were analysed for the use of the regular plural -s in obligatory context. There were two pictures considered to provide the required obligatory context for the regular plural -s. Picture 2 shows a woman putting a child's boots on and picture 10 shows three apples dropping out of a woman's shopping bag. In addition, the irregular plural is targeted in Picture 5 where a cat is catching two mice or rats.

The children's data was analysed to see whether the regular plural -s was used correctly (e.g., *apples*) when required by the obligatory context, or whether the plural -s was omitted from the noun and the bare form was produced (e.g., *apple*). The child could produce the item more than once in their response and each example was scored, although repetition of the same word or word combinations was not scored as per the Pierce et al. (2013) criteria. An alternative noun was accepted (e.g., *tomatoes*) and scored similarly for the plural or bare form. If the child did not attempt the noun (or a similar alternative), the child's response was not included (e.g., *the woman is dropping her shopping*). If the child produced an additional plural not in the picture, this was not scored as it was unknown whether the child was talking about a single or multiple target. The picture of the woman dropping the apples also shows a boy picking up *one* of the apples. The child's description of the apples falling out of the bag was scored for the use of plural -s due to the context provided by the picture (Pierce et al., 2013). The description of the boy's action was excluded from analysis as it was unknown whether the child's target was the plural or singular form.

The following shows an example of the scoring system used:

One participant's response to the question "Now, look at this picture. Tell me what's happening" for Picture 10

She dropped the apples. Dropped the apples. Little bag. Her apples and bananas. The boy is picking apple.

Regular plural -s is scored correct where underlined. The second *apples* is not scored as considered repetition (defined as used with the same surrounding words). The final *apple* is disregarded from scoring as it is not clear from the context whether the target is a plural or singular. The plural -s in *bananas* is not scored as addition/not in picture.

There are two additional potential plurals in the RAPT; stairs and glasses. These were not included in the analysis as they as they are generally produced in the plural form. Therefore, they are potentially learnt as single lexical items as do not provide examples of the child marking plurality. The irregular plural *mice* was scored separately and this data is not included in analysis as irregular forms are thought to be learnt as single lexical items and do not require the use of the regular plural rule. Only 17 out of 52 participants produced the irregular form. A total of 16 children produced the bare form (*mouse*) this was scored as use of the bare plural form in obligatory context (together with *boot* and *apple*). If the child used the plural form *rats*, this was scored as correct use of the regular plural. Two participants produced the overregularised error (i.e., *mouses* /mausiz/). These two responses were excluded from the analysis.

Percentage correct in obligatory context (PCOC) scores were calculated for each child (number of correct uses divided by the number of obligatory contexts (correct use + bare form) multiplied by 100). This was based on the method outlined in previous research (e.g., Paradis et al., 2003; Pierce et al., 2013). Some authors (Paradis et al., 2003) recommend that a minimum of four examples should be obtained for the analysed morpheme to be reliably scored. Given there are only two targets of the regular plural -s in the RAPT, it was not possible to find examples of four obligatory contexts for all participants. It is important to note that this analysis is to compare the use of the RSPT morpheme -ed to the use of the regular plural -s rather than to ascertain whether a morpheme is being used consistently (i.e., has been acquired by the child). It should also be noted that the regular plural -s was targeted in far fewer examples than the RSPT -ed. Therefore, the child had far fewer opportunities to produce the regular plural -s and this should be considered when comparing the two morphemes.

Analysis of the TEGI

The TEGI past tense probe was used to elicit regular and irregular past tense forms and the children's responses on this measure were explored to compare the two. Obligatory context was provided by the stimulus, the child is asked to describe the second picture of a pair; the first shows the action in progress and the second shows the action clearly completed. In addition, the question prompt that the child is asked is exactly the same for every picture. The assessment starts with two examples and the examiner models the correct use of the regular past tense twice (if the child is unsuccessful). The picture and the prompt are considered obligatory context for the use of the RSPT, however obligatory context also had to be established by the utterance structure. For example, if the child responded in the present continuous tense (e.g., the girl is climbing), this was not considered obligatory context for the RSPT. Utterances were analysed and scored as either: 1) correct use in obligatory context (e.g., the girl climbed the ladder), 2) omission of the regular past tense morpheme in obligatory context (e.g., the girl climb the ladder), 3) omission of tense in obligatory context (e.g., the girl climbing the ladder). This third scoring was due to the progressive -ing form performing similarly to the bare form in English; neither marking tense (Rice & Wexler, 1996). All other utterances were recorded but not included in the scoring for the use of the regular or irregular past tense (e.g., use of present progressive, use of do or have, verb omitted, no response etc.).

Percentage correct in obligatory context (PCOC) scores were calculated for each child (number of correct uses divided by the number of obligatory contexts (correct use + bare form + -ing form) multiplied by 100).

The responses on the RAPT were not considered suitable as the context provided by the questions was considered insufficient to provide obligatory context for tense. The RAPT asks questions using a range of tenses in an attempt to elicit a range of structures and morphosyntax (e.g., For Picture 3: "What has been done to the dog?"). However, the pictures provide ambiguous contexts (e.g., Picture 3 only shows a dog tied to a post). Given the comprehension difficulties experienced by children with DS, it was decided that many questions would not be understood, resulting in the child just describing the picture (e.g., dog barking).

Analysis

Of the 52 participants, one participant's responses on the TEGI did not produce any obligatory context for the regular past tense (this participant's responses mostly included the use of present progressive tense and the use of *do*). Therefore, this participant was excluded from the analysis. The responses for the remaining 51 participants, all involved obligatory context for at least one plural (mean 2.12, range 1-4) and one past tense form (mean 5.94, range 1-9).

Non-parametric tests were used to compare PCOC scores because the data was not normally distributed. Wilcoxon signed-ranks tests were used to investigate whether one morpheme was used more than another. As the regular past tense PCOC data was used for a second statistical test (see below) the Bonferroni Correction was used to adjust the p value to 0.025.

A comparison, using the Wilcoxon signed-ranks test, revealed that the PCOC scores for the plural -s were significantly higher than those for the RSPT (z = -5.872, p = <0.001 original figure). Figure 17 shows the range in scores.

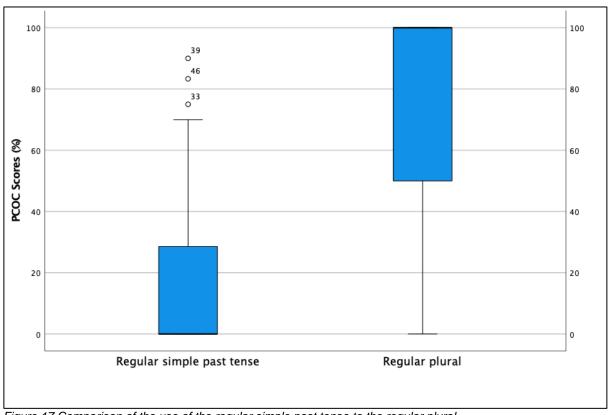


Figure 17 Comparison of the use of the regular simple past tense to the regular plural
The figure shows PCOC scores for the regular plural on the RAPT and regular simple past tense on the TEGI
past tense probe at time 1 (pre-intervention) (N=51)

As can be seen in figure 17, the median score for the RSPT was zero, with 34/51 of the children scoring at floor. The median score for the regular plural was 100% with 33/51 receiving this score. It should be kept in mind that there were less obligatory contexts for the use of the plural (mean 2.12) than the past tense (mean 5.94).

8.4.2. Regular vs irregular morphemes

The data from the TEGI past tense probe was then analysed to compare the scores on the irregular verbs and regular verbs. All 52 participants completed the TEGI. In addition to the participant whose responses did not involve any obligatory contexts for the RSPT, two additional children did not produce responses involving obligatory contexts for the irregular simple past tense (one produced all present progressive forms whilst the other produced a range of responses including omitting the verb, use of *do* and not responding). These three participants were excluded from the analysis.

A Wilcoxon signed-ranks test was used to compare the regular and irregular tense for 49 children. Results revealed that the PCOC scores were not significantly different (z = -1.195, p = .232, Bonferroni corrected) shown in Figure 18.

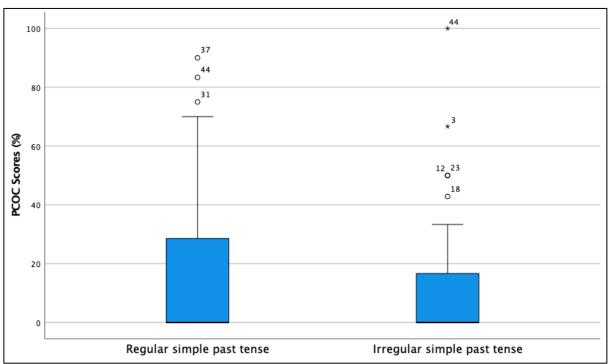


Figure 18 Comparison of the use of the regular simple past tense to the regular plural
The figure shows the PCOC scores for the regular simple past tense and the irregular past tense on the TEGI
past tense probe at time 1 (pre-intervention). (N49)

As is shown in Figure 18, the median score was zero for both the use of the regular and irregular past tense. A total of 34/49 children failed to produce a single regular past tense form and 35/49 children failed to produce a single irregular past tense form. Whilst evidence is limited, it has been reported that irregular past tense is less impaired than regular past tense in individuals with DS. Given this inconsistency and the fact that the majority of children were scoring at floor, the data was explored to compare whether those children who were using regular or irregular past tense forms showed any differences in their use. Any child who marked four or more RSPT forms was included. As the TEGI past tense probe contains 10 regular target verbs, a score of four would be equivalent to 40% use correct. The TEGI only contains eight irregular verbs and therefore any child who scored three or above was included (37.5% use correct). A total of nine children met these criteria, their TEGI PCOC scores are shown in Figure 19 for regular and irregular forms used.

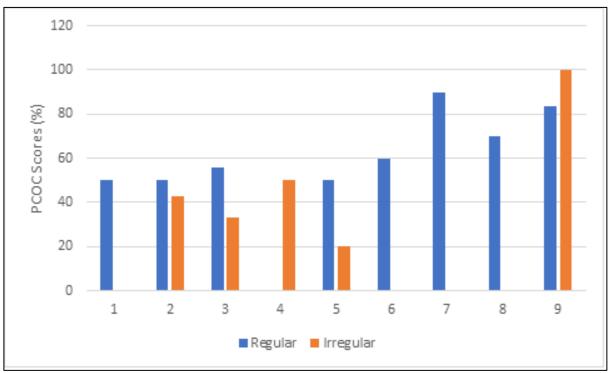


Figure 19 Bar chart showing the PCOC scores for the use of regular and irregular past tense on the TEGI past tense probe at time 1

The data is for the children who were demonstrating some use of the past tense at t1 (N9)

Wilcoxon signed-ranks test was used to compare the regular and irregular tense for these nine children. Results revealed that the PCOC scores were not significantly different (z = -1.779, p = .075).

8.5. Summary of key findings

The results showed that the group of 52 children with DS were significantly impaired in their use of RSPT at time 1. However, their use of a non-tense morpheme (plural s) appeared relatively unimpaired in contrast. This supports the theory that children with DS have more difficulty with tense vs non-tense morphemes. The results of the main study support the finding that the intervention was effective, with the intervention group making significant gains over the delayed intervention group at t2. Furthermore, the delayed intervention group made similar gains at t3, after they too had received the intervention. In addition, the gains in the use of the RSPT generalised to untaught verbs and to overgeneralisation errors on irregular verbs. This generalisation supports the theory that the children had learnt to apply the grammatical rule. Whilst a small group of children did not make significant gains, it was not possible to identify any factors that accounted for their lack of progress from the baseline and intervention measures administered at t1. Gains made by children in their use of the RSPT did correlate with TA scores regarding delivery of the session (e.g., organisation, tailoring to individual needs, compliance and behaviour management).

9. Discussion

Individuals with DS experience difficulties with a range of speech and language skills including; speech (e.g., Burgoyne et al., 2021; Dodd, 1976; Kumin, 1994; Kumin et al., 1994), vocabulary acquisition (e.g., Berglund et al., 2001; Miller et al., 1995; Stoel-Gammon, 2001) pragmatic language skills (e.g., Abbeduto, 2008; Berglund et al., 2001; Smith et al., 2017) and syntax (e.g., Frizelle et al., 2018; Perovic & Wexler, 2019; Thordardottir et al., 2002). The profile of these difficulties is uneven, with receptive vocabulary being reported to be a relative strength for individuals with DS (e.g., Abbeduto et al., 2007; Chapman et al., 1991; Conners et al., 2018; Cuskelly et al., 2016; Næss et al., 2011). One of the biggest areas of difficulty is morphosyntax, where individuals with DS show high levels of omission errors that continue throughout life (e.g., Bol & Kuiken, 1990; Chapman et al., 1998; Eadie et al., 2002; Laws & Bishop, 2003). The evidence is mixed as to whether this difficulty is evident across morphosyntax generally or whether particular morphemes are impacted. However, there is agreement that tense morphemes are severely impaired compared to nonverbal mental age matched controls (e.g., Chapman et al., 1998; Laws & Bishop, 2003; Ring & Clahsen, 2005). Despite this, there have been very few studies investigating these difficulties in detail or evaluating interventions to remediate these difficulties. The main aim of this study was to evaluate the effectiveness of an intervention, using implicit and explicit methods, specifically designed to target an improvement in the use of the RSPT for children with DS. This chapter will discuss the effectiveness of this intervention and what has been learnt from this study to add to the literature on the morphosyntactic difficulties of children with DS.

9.1. How effective is an intervention that teaches the use of the regular simple past tense forms, using implicit and explicit techniques, for children with Down syndrome?

This chapter starts by exploring this first research question. In order to evaluate an intervention designed for a specific population such as DS, it is important to establish whether the participants were typical of the population with DS before intervention.

9.1.1. The profile of the participants preintervention

Children had to meet a number of criteria to be included in the study. They had to be attending years 3-6 in mainstream school and have English as a first language. In addition, they were required to be combining two or more words in spoken utterances. These criteria were used to recruit children who were thought to be at an appropriate age (7-11 years chronological age) and stage of language to support the use of the RSPT. The language stage was followed up at the first t1 assessment, where measures of the child's ability to produce the sounds to mark the past tense were administered (TEGI phonological probe) as well as measures to ascertain whether the RSPT -ed had already been mastered. Following assessment, three children were excluded from the study as they were already using the RSPT consistently (over 80% correct TEGI past tense probe and at least one correct past and present tense form on the RAPT). These three participants demonstrate that some children with DS are managing to acquire some tense morphology.

On several of the baseline measures, including measures of nonverbal mental age and receptive language, the children's scores were so low that they were below the test's lowest standard score. The median standard score on the Raven's CPM was <60 (age equivalence <4 years), 37/52 children received this score. Therefore, raw scores were used to compare the two groups and any intervention effects. This is typical of studies that include similar aged children to the current study (e.g., 8;8-14;10 years (Laws et al., 1995) 7;5-17;10 years (Laws, 2002)). Furthermore, it is common to report raw scores rather than age equivalences when evaluating intervention for this population (e.g., Burgoyne et al., 2012a; Laws, 2002; Laws & Bishop, 2003; Mengoni et al., 2014).

Nonverbal mental age

Individuals with DS experience intellectual impairment although the extent of this impairment is varied, with scores of iQs between 30 to 70 (Chapman et al., 2002). As part of the recruitment criteria, the children were all attending mainstream primary school, and children with DS who have more additional needs commonly attend specialist provision (Hargreaves et al., 2021). The Raven's Coloured Progressive Matrices (Raven, 2008) was chosen to measure nonverbal mental age. It is designed for children 5-11 years and gives age equivalence scores for as young as four years.

Furthermore, it had been used successfully with groups with DS in the past (e.g., Laws & Bishop, 2003; Perovic, 2006). However, as discussed, scores were very low and therefore raw scores were used for analysis. These raw scores were comparable to previously reported mean raw scores (12.36), for a group with a higher mean chronological age (10;2 years) (Laws et al., 1995). Also, age equivalences are in line with those in previous studies who have successfully received language intervention targeting grammatical morphology (Sepúlveda et al., 2013). Therefore, the children receiving the intervention appear not dissimilar to other groups with DS regarding nonverbal mental age and at a stage where an intervention targeting morphosyntax could potentially be effective.

Vocabulary

Receptive vocabulary has been reported to be a relative strength for individuals with DS (e.g., Abbeduto et al., 2007; Chapman et al., 1991; Conners et al., 2018; Cuskelly et al., 2016; Næss et al., 2011) with some studies reporting receptive vocabulary in line with nonverbal mental age (e.g., Abbeduto et al., 2007). In the current study, mean standard scores of receptive vocabulary (73.58 (95% CI 72.03, 75.66)) and expressive vocabulary (mean standard score 71.32 (95% CI 67.95, 73.44)) do not differ significantly from each other (t = 1.92; d.f. = 102; p = 0.06). When the receptive and expressive vocabulary scores were compared, the group scores were greater for receptive vocabulary compared to expressive vocabulary although this was not significant. The literature suggests that receptive vocabulary is typically ahead of expressive vocabulary and that this dissociation starts to emerge as young as 10-49 months (Cardoso-Martins, et al., 1985; Caselli et al., 1998). Therefore, a significant advantage regarding receptive vocabulary might have been expected. A metaanalysis (Næss et al., 2011) found expressive vocabulary significantly lower than receptive vocabulary, however receptive and expressive assessments were not always comparable. Næss et al. (2011) report receptive measures of picture selection only in the studies that were included in the meta-analysis. However, expressive measures included picture naming, word definitions, and opposites. In the current study, expressive vocabulary was measured using a picture naming task which is more closely matched to the picture selection task used. The comparable nature of these tasks may be responsible for the lack of a significant difference between these measures. Similarly, a lack of significant difference between the two has been reported for children with DS of similar ages (Burgoyne et al., 2012a). Whilst receptive vocabulary was ahead of expressive vocabulary overall, in line with the literature, this was not the case for all participants. When the individuals scores are observed, 15/52 (28.9%) had higher standard scores for expressive vocabulary compared to their receptive vocabulary scores. Whilst this appears contradictory to previous research, the majority of studies only report group standard scores.

In terms of receptive vocabulary raw scores, these are roughly in line with previous intervention research on children with DS (e.g., Burgoyne et al., 2012a). The children in the Burgoyne et al. (2012a) study were slightly younger (mean age 6;7 years) and therefore their raw scores were lower as would be expected. Also, they reported similarly large standard deviations (e.g., receptive vocabulary 10.88, expressive vocabulary 11.85) to those observed in this current study. Again, this supports the similarities between the group in this intervention study regarding vocabulary and the range of individual differences typical of this population.

Grammar

As expected given the literature, the children's performance on the TROG-2 was extremely low, with a mean standard score 55.48 (95% CI 54.94, 56.02) with 48/52 participants scoring the median standard score of 55. The children scored significantly lower on the measure of receptive grammar than the measures of vocabulary (receptive and expressive) as is evident from the confidence intervals for these measures.

Expressive grammar measures included the RAPT and the CELF-4 Recalling Sentences subtest. Both groups demonstrated variability on both the information and grammar scores from the RAPT as shown by the larger standard deviations. The group means are higher than those of the Burgoyne et al. study (2012a), expected to reflect the higher mean chronological age of the current study's participants. However, the standard deviations are similar, falling between 5 and 7.26 for both studies. Many of the participants in the current study found the sentence repetition task (CELF 4-UK) extremely difficult, with 14/52 scoring zero. The remaining 38 participants' raw scores ranged from 1-26 with a mean raw score of 3.0, demonstrating the expressive difficulties faced by this population.

Morphosyntax

As discussed in Chapter 5, the severe difficulties with morphosyntax are well reported in previous studies. The group of participants in the current study reflect this, with the majority of children scoring very low on all the measures of tense; TEGI past tense probe, TEGI third person singular probe and the bespoke measures developed to measure the use of the RSPT. Standard deviations are small supporting the evidence that the RSPT is a challenge for the majority of children with DS (Chapman, 1998; Eadie et al., 2002; Laws & Bishop, 2003; Ring & Clahsen, 2005).

Reading

As the intervention uses print as one of the strategies, a measure of word reading and letter sound knowledge was administered at t1. In the current study the mean score on both subtests is similar for both groups (not significantly different) and falls in between the scores reported previously for younger children aged 5 to 10 years (Burgoyne et al., 2012a) and older children aged 7 to 16 years (Mengoni et al., 2013). Therefore, the literacy scores for this group were in line with participants in previous studies based in the UK.

Summary

The baseline assessments reveal that the profile of the participants in the current study was broadly in line with participant groups described in previous research. The Burgoyne et al. (2012a) study involved children at primary school in the UK. Therefore, the similarities to this comparable group are supportive that the children in the current study were not dissimilar. Other studies involving tense and individuals with DS, typically include older participants (e.g., Chapman et al., 1998; Laws & Bishop, 2003; Ring & Clahsen, 2005). The children in the current study have moderate cognitive delays and their receptive and expressive vocabulary skills are significantly above their receptive grammar skills. This dissociation between vocabulary and grammar is in line with the procedural deficit hypothesis which argues that vocabulary is learnt explicitly (through the declarative memory system) whereas grammar is learnt implicitly (through the procedural memory system). If this hypothesis was correct, it would appear that children with DS have a relative strength in the declarative system compared to deficits in the procedural system.

In addition to the overall baseline scores, the variability within the sample is also in line with the research. This is demonstrated by the relatively wide range and SD scores compared to typical development, but commonly reported for children with DS. Therefore, it can be concluded that the children participating in the current study are typical of children with DS at this age.

9.1.2. Evaluating the effectiveness of the intervention

To evaluate the intervention, four measures of the use of the RSPT were included; 1) TRSPTP, the 40 verbs taught as part of the intervention, 2) URSPTP, 20 verbs not taught in the intervention, 3) TEGI regular past tense probe (the eight irregular verbs were scored separately), 4) bespoke Narrative Retell, nine RSPT verbs were targeted through a story retell using pictures. These four measures were used to calculate a composite measure of the average of these four measures, called the Total past tense score. At t1 the children were generally all scoring poorly on all of these four measures with a high number of children scoring at floor.

9.1.2.1. Time 2

The critical point to evaluate the effectiveness of the intervention was at t2, when the intervention group had completed the intervention and the delayed intervention group had not yet received the intervention. The Total past tense score at t1 was subtracted from the Total past tense score at t2 to calculate any gains made on this measure. At t2 the intervention group had made clear significant gains on this overall measure of past tense with large effect sizes as shown in Figure 8. This evidence convincingly shows that the intervention was effective.

The use of the composite measure allows overall gains of the use of the regular past tense to be analysed and compared to other measures. In addition, responses to different tests provide information on the contexts in which the children were using the RSPT.

Highly structured elicitation tasks

The composite score included a range of measures of past tense including standardised and bespoke, structured elicitation tasks; TEGI past tense probe, TRSPTP, URSPTP. The advantage of highly structured elicitation tasks is that they

have the potential to provide more obligatory contexts for a specific targeted morpheme. The TEGI targets the elicitation of 10 RSPT forms. Whist this is adequate for providing information on the use of the RSPT in general, it does not provide more than three obligatory contexts each for the three phonological forms of the RSPT (e.g., /t/, /d/ and /Id/). The bespoke TRSPTP and the URSPTP provided many more obligatory contexts, taking into account the various phonological forms. Furthermore, the high number of items (60 in total) provided a range of voiced and voiceless clusters to be elicited. This helped to provide obligatory contexts for the full range of forms that the RSPT can take. This also helped to overcome any specific speech difficulties the child might have with one (or more) particular forms (e.g., a difficulty with fricatives might mean difficulties marking brushed /brx[t/ and laughed /la:ft/ but the child would potentially be able to mark cooked /kukt/ and hugged /hngd/). The gains on each of these three measures were very large and support the effectiveness of the intervention on the use of the RSPT. The limitations of this type of elicitation task, include a high level of structure provided by the assessor and the acceptable fragment responses that are often elicited (e.g., the response is an incomplete utterance or even a single word). These fragment responses, whilst acceptable, provide limited information about the child's use of the target in complete utterances. This high level of structure, where the adult provides the model answer for the first few examples and then a lead in prompt (e.g., here the boy is brushing, now he is done. Tell me what he did? additional prompt allowed *He...*) potentially provides a support not available in natural language. Therefore, any results from highly scaffolded, structured tasks may not reflect gains in more spontaneous language. For this reason, a bespoke Narrative Retell was created.

Narrative retell

Whilst narrative retells are considered structured elicitation tasks, they provide a more natural language sample with less direct scaffolding. Conversation samples were considered as a measure for the current study. However, narratives have been found to elicit more grammatical morphemes in typically developing children (Leadholm & Miller, 1992) and children with delayed language (Sealey & Gilmore, 2008) compared to conversation. Furthermore, narratives with pictures have been found to produce longer utterances in individuals with DS (Miles et al., 2006). The child is required to use the target in complete utterances (or any incomplete utterances can be observed). Therefore, the bespoke Narrative Retell was developed to provide a more

spontaneous language sample, with potentially longer utterances including grammatical morphemes. This allowed the observation of whether the child was using the RSPT in this context. Again, effect sizes were large in favour of the intervention group and 22/26 children were using the RSPT (mean 3.65 range 1-7) in narrative retells following the intervention (compared to 10 children at t1, mean 0.81, range 1-5). This highlights that the intervention was effective in producing significant gains in narrative language samples. The Narrative Retell targets elicitation of nine regular past tense verbs and similarly, the TEGI targets elicitation of 10 regular past tense forms. Whilst gains are still large for the narrative retell, they are not as large as gains in the more scaffolded, structured elicitation task. This potentially reflects a better use of the RSPT when structure and supports are provided, the gains in use during the more spontaneous narrative retell show gains in more natural language. This highlights the need for careful consideration when selecting measures of morpheme use. A range of measures such as those used in the current study, provide evidence of use across a range of elicitation methods.

General language measure

In addition to the direct measures of the RSPT, the intervention group also made significant gains on their scores on the RAPT grammar, a more general measure of language. The data was explored to observe whether a change in the use of the RSPT had brought about this change in score. The format of the RAPT grammar provides a number of challenges, the foremost being the level of understanding required. The RAPT asks a series of 10 questions, each changing the tense of the question from the previously asked one. Therefore, in order to determine whether the response elicits the intended tense, the child must understand the question. Given the significant receptive language difficulties associated with DS (and observed in the children in this study at t1), this could not be assumed and in fact is entirely unlikely. This results in the picture not providing the obligatory context for the use of a particular morpheme (i.e., if the child has not understood the question, they are only left with the option of describing the picture). Therefore, the data could not be reliably analysed for the gains in the use of the regular past tense due to the lack of obligatory context. Whilst this limitation of the RAPT results in not being able to determine exactly what has brought about these gains, nevertheless the intervention group have made gains on a general language measure following the intervention. This is atypical of previous research

which reports poor generalisation to more general measures of language (e.g., Burgoyne et al., 2012a).

Sentence repetition

Finally, gains were also large for the bespoke RSPT Sentence Repetition probe. This was not included in the composite measures as it was not considered a measure of the child's use of past tense. However, it provided two important outcomes. Firstly, it served as an additional measure to determine whether the child could produce the RSPT form. The probe required the child to repeat back a very short sentence (e.g., the boy crawled). If the child repeated the full sentence correctly, they scored three. If the child produced a part utterance that included the RSPT form (e.g., boy crawled) they scored two. If the child failed to produce the RSPT form at all (e.g., boy crawl) they were asked to repeat just the RSPT form (e.g., crawled). If this was produced correctly, they scored one. The articulation of the word/morpheme did not have to be correct, but the past tense morpheme had to be attempted (e.g., the child might omit the /// from crawl /krz:/ but /krz:/ but /krz:/d/ would be accepted as attempting the -ed morpheme).

The mean score for the entire group at t1 was 16.79 (range 6-30). The range shows that all children produced at least a few examples of the regular past tense in repetition and therefore had the speech skills to do so. However, this was not consistent with many children failing to imitate simple sentence structures without omission errors. Only three children scored the maximum 30 points. Secondly, it highlights the high level of difficulty in repeating very short simple sentences. The scores in the CELF-4 somewhat reflect this difficulty, but the structures in the RSPT Sentence Repetition was much simpler and only contained three words (determiner-noun-verb). This perhaps highlights the phonological short-term memory difficulties that individuals with DS are faced with. As discussed in Chapter 5 (2.5), verb learning is suggested to require the listener to hold onto a more complex syntactic frame in order to extract the relevant lexical information and the syntax and morphosyntax. This sentence repetition measure suggests children with DS are unable to receive and hold onto simple subject-verb clauses long enough to repeat the sentence without losing the morphosyntax. This is in line with the research regarding the phonological short-term memory difficulties, particularly the difficulties with the phonological loop discussed in Chapter 5 (5.2.3) and potentially further impacted by the hearing difficulties discussed

in Chapter 5 (5.2.2). The difficulties with simple sentence repetition could be a result of the child not hearing the less salient morphosyntax (Whan Cho & O'Grady, 1997) and/or the morphosyntax that they do hear is not retained by the phonological short-term memory (comprising of the phonological loop and the phonological input store) (Seung & Chapman, 2000).

Given the deficits in the RSPT at t1, it strongly suggests the regular past tense -ed is not well established in these children which would place it more at risk in terms of phonological processing (Chapman et al., 1998). If the children are not able to consistently retain utterances with intact morphosyntax, they would be significantly impaired in extracting the patterns of morphosyntax. This is in line with the evidence that phonological short-term memory capacity constrains new word learning (e.g., Baddeley et al., 1998). If children with DS have difficulty with hearing and retaining words with consistent form well enough to create accurate phonological representations in the lexicon for nouns, verbs (with a higher frequency of changing forms) would be even more challenging. This extreme difficulty in sentence repetition is not unusual in DS, with individuals with DS preforming worse on sentence repetition above two words, compared with nonverbal mental age matched controls with intellectual disability (Marcell et al., 1995).

Remaining measures

The remaining measures in the intervention battery saw no significant gains following intervention. This included scores on the RAPT information and the following scores on the Narrative Retell; total number of words and number of different words. The lack of gains on these measures may be expected; the intervention did not target increasing utterance length. All intervention resources only contained simple sentences (with a single verb). There was also no significant gain on MLU in the bespoke narrative retell. This is perhaps surprising as there were significant gains in the use of the RSPT morpheme which might be expected to increase these overall scores. The effect size is small (d=0.20) but not significant. The standard deviation in the total number of words for both groups at all timepoints is considerable given the length of the story (which reflects the individual differences). This may partly be responsible for this difference not being significant. Further, the delayed intervention group made quite considerable gains in mean total number of words at t2 (e.g.,

delayed intervention group t1 mean 40.27 (16.36), t2 mean 49.62 (22.31). This gain was not due to significant improvements in the use of the RSPT at t2. This inflation in the delayed intervention group's scores on total number of words is due to unknown factors but may be negating the improvement in the RSPT impacting the total number of words for the intervention group. This highlights the problems with relying on MLU to demonstrate improvements on a particular morpheme and the necessity of more detailed analysis.

Finally, the other measures showing no significant gains following intervention are the other measures of tense; irregular past tense or third person singular -s. Even though the irregular past tense was not targeted in the intervention the children did sometimes use overregularisation errors to mark past tense on these forms. There were eight irregular verbs tested in the TEGI past tense probe. At t1, the intervention group were scoring poorly on this measure (mean 0.42, SD 0.64) with only nine children scoring; seven scored 1 and two children scored 2. At t2 the mean remained low (0.35, SD 0.69) with seven children scoring: six scoring 1 and one child scoring 3. However, at t2 the children are not continuing to omit tense (e.g., producing a bare form eat or eating), rather they are now marking tense by applying the regular rule they have learnt to irregular verbs (e.g., eated /iːtɪd/). In terms of the effectiveness of the intervention, the intervention group have made significant gains in their ability to communicate past tense on irregular verbs through overgeneralisation of the regular past tense rule; errors of overregularisation at t1 were 0.08 (SD 0.27), errors of overregularisation at t2 were 3.69 (SD 2.90). Only two children produced a single overregularised error at t1 compared to 21 at t2 (range 1-8). Therefore, the intervention has been effective in enabling the children to mark past tense on irregular verbs with overregularisation errors. The very low numbers of children using any irregular verbs at t1, and the significant gains in overregularised errors, supports the effectiveness of the intervention in improving past tense marking more generally. The issue of the use of irregular past tense by children with DS is discussed further, later in this chapter when the second research question is reviewed. As the intervention was targeting tense, any improvements in the use of the regular past tense may have led to gains in other tense morphemes if the children had improved their general understanding of the grammatical contrast of tense. Therefore, discussion about these measures of tense is included in 9.2 reviewing the second research question regarding generalisation.

9.1.2.2. Time 3

Following the critical t2 assessments, the delayed intervention group then received the intervention. To explore any gains made on the use of the RSPT by the delayed intervention group, their t2 scores were subtracted from their t3 scores on the Total past tense score. Figure 10 shows clearly that the delayed intervention group make similar gains to the intervention group once they too have received the intervention. This further strengthens the evidence of the effectiveness of the intervention; a second group of children who perform poorly on all measures of regular past tense before intervention, make large gains following intervention.

The other critical t3 analysis was whether the intervention group had maintained the gains they had made 12-14 weeks after receiving the intervention. It is important to note that the intervention group had returned to "business as usual" during this time. As part of the intervention, the Friday consolidation session included sticking the activities from the week in a book which was then reviewed to talk about what the child had done previously in the intervention (using the regular simple past these). At the t2 assessments, the SLT researcher collected the intervention books and did not return them until the t3 assessments. During the 12-14 weeks business as usual the TAs did not have any activities, manual instructions or the intervention book to review. It is clear from Figure 10 that the children in the intervention group maintained gains approximately three months following the end of the intervention.

9.1.2.3. Individual differences

The literature on individuals with DS reports that a wide range of individual differences are common (e.g., Burgoyne et al., 2012a; Laws & Bishop, 2003b; Miller et al., 1995; Zampini & D'Odorico, 2013). The preintervention measures demonstrate this is true for the participants in this study, with large standard deviations for a number of measures of language and reading including; receptive and expressive vocabulary, receptive grammar, word reading. When the gains on the use of the regular past tense are explored, these individual differences are also evident as shown on Figure 9.

Gains on the use of the RSPT were significant overall, with large effect sizes. However, a small number of children (five) made no or very limited progress. There are several possible reasons for this evident in the correlation analysis. Firstly, there is a high

correlation between nonverbal mental age and all other baseline measures. This may suggest that the children with higher nonverbal mental ages are potentially learning more quickly in general and so performed better on the use of the regular past tense following intervention. Therefore, perhaps these five children who made no or little progress, were not at a cognitive or language stage to benefit from this intervention. However, other children with the same low language and cognitive scores did benefit. Therefore, it would be difficult to select suitable children for this intervention based on these baseline measures. The gains on the use of the RSPT were also highly correlated with the overall scores of the TA's skills. This is in line with previous studies who have rated TA effectiveness in delivering intervention (e.g., Burgoyne et al., 2012a). This suggests that the four areas of session delivery that were rated may play a role: organisation, tailoring to individual's needs, compliance and behaviour management. There was a positive correlation between these scores suggesting that the lower the TA score, the less gains children make on the use of the RSPT. In fact, the five children who made no to limited gains, worked with TAs who had the five lowest TA scores. The reason for these low scores could be attributed to a number of different factors not measured in the observations. However, it raises the importance of TA training and review if they are to deliver daily intervention sessions.

9.1.3. Summary and implications

The first research question was to evaluate the effectiveness of an intervention for children with DS, targeting the use of the RSPT using explicit and implicit methods. There is clear evidence at t2 that the intervention group made significant gains on all measures of the RSPT. In addition, the delayed intervention group made similar gains at t3, once they had also received the intervention. Further evidence supporting the effectiveness, was the maintenance of the gains made by the intervention group 12-14 weeks later. An intervention that led to immediate gains but saw children's scores falling after intervention ceased would considerably reduce the effectiveness and rationale for future use.

The gains in intervention are in line with previous research evaluating interventions on grammar for groups of children with intellectual disability that include DS (Bibi et al., 2019; Tobin & Ebbels, 2018) and for those specifically for individuals with DS (Buckley 1993; 1995; Sepúlveda et al., 2013). These previous interventions have reported

employing explicit methods to develop grammar. Similarly, the current study also used explicit methods to support the understanding and use of the RSPT. This evidence suggests that for individuals who have not implicitly learnt grammar, such as those with DS, the use of explicit methods can be beneficial. This provides some further support for the suggestion that children with DS have a relative strength with the declarative memory system (responsible for explicit learning) which could potentially be responsible for the relative vocabulary strengths.

A meta-analysis (Smith et al., 2020) concluded that children with DS have the potential to benefit from language interventions and the evidence from this study certainly supports that conclusion. A family background questionnaire was returned for 38 of the children, which requested information about their current speech and language therapy (full information can be found in Chapter 7 (7.2.1). Of those 38, a total of 35 reported receiving speech and language therapy. However only two children had targets relating to morphosyntax; one had a target regarding the RSPT. The three most common targets were syntax, vocabulary and speech. Given the relative strength in vocabulary for individuals with DS, it seems vocabulary is an unsubstantiated area for targets. The evidence from this study supports the benefits of working on morphosyntax to target the deficits in receptive and expressive language seen in children with DS of this age.

9.2. If such an intervention can be shown to be successful, will learning generalise, and, in particular, will children demonstrate errors of overregularisation after the intervention?

The success of the intervention programme allowed an investigation into whether the children had generalised the grammatical rule for the RSPT to untaught items and whether they demonstrated overregularisation errors. This would strengthen the predicted hypothesis that the children could master the rule for the RSPT, contributing to our understanding of the nature and causes of the children's language difficulties.

When designing the intervention, consideration went into methods of supporting generalisation, as whilst gains on taught items are common for children with DS, generalisation to untaught items is not (e.g., Burgoyne et al., 2012a). The intervention could have focussed on teaching a smaller number of verbs. This would have

increased the repetition of these chosen forms and potentially have increased the likelihood that gains would have been made on the taught verbs. This would be more likely if children with DS learnt regular verbs as single lexical items, as suggested for children with DLD (e.g., Marshall & van der Lely, 2007). Whilst gains made in this way would be potentially beneficial, it would mean learning every regular past tense form as a new vocabulary item. This would involve relatively slow progress and the children would not be able to generate new forms if they did not learn and extrapolate the rule. Furthermore, this is not the method thought to be used by typically developing Englishspeaking children who are considered to learn grammatical rules implicitly (e.g., Perruchet & Poulin-Charonnat, 2015). Implicit learning occurs over time and in terms of grammar, the rules are extracted with the relevant grammatical morphemes being stored with the associated phonological and semantic information (Pinker, 1999). Ullman's declarative/procedural model (2001) argues these morphemes are then combined with the relevant lexical items to produce multimorphemic words (e.g., jump + -ed to form jumped). The difficulties in grammar experienced by children with DLD have been suggested to be a result of implicit learning (e.g., Ullman & Pierpont, 2005) or from more specific difficulties with implicit sequence learning (e.g., Hsu & Bishop, 2014). The procedural deficit hypothesis suggests that a deficit with procedural memory (responsible for implicit learning) is a result of underlying brain abnormalities (e.g., Ullman & Pierpont, 2005). Implicit learning difficulties have been reported for individuals with DS (e.g., Bussy, 2011) although the research is mixed (e.g., Rondal, 2017). Therefore, an intervention that makes use of explicit teaching of a grammatical rule, could potentially be beneficial.

If explicit teaching of a grammatical rule was effective, then the question is whether the children would use the rule implicitly for novel items not explicitly taught. To try to answer this, the currently study included a number of measures of generalisation.

9.2.1. Generalisation to untaught items

9.2.1.1. Regular simple past tense

The decision was made to explicitly teach the rule (rather than rely solely on implicit strategies) and use a relatively high number of verbs; 40 verbs were included in the 10-week intervention. Each week four new verbs were introduced and throughout the

week the child was taught to apply the regular rule to this new set. Children with DS have been shown to learn new vocabulary quickly in experimental studies although duration of maintenance is questioned (e.g., Chapman et al., 1990). Therefore, it was potentially possible for the child to learn each new set of verbs as single lexical items or to understand and apply the rule.

The bespoke URSPTP was included as the closest generalisation measure. These additional 20 words were matched for phonological form; the untaught verbs were equally weighted for the three phonological forms (e.g., /t/, /d/ and /ɪd/. In addition, they were equally weighted for order of acquisition (an equal percentage of items from vocabulary checklist 1, 2 or 3). It was hypothesised that if the children had learnt the 'rule', they would show gains in the use of the regular past tense on these untaught verbs.

Both groups made significant gains on applying the regular past tense rule to these matched verbs. These verbs were matched on order of acquisition based on early language development. Therefore, although these verbs were not used in the intervention, it is likely that the children would have heard these verbs, sometimes marked for past tense, during the intervention period as part of everyday language. Theoretically, the intervention may have increased the children's awareness and understanding of the morpheme. By developing the child's representation of the morpheme (in terms of both its form and meaning) it may have become less vulnerable. This potential increase in its resilience may have resulted in an increase in retention by the phonological short-term memory. Thus the children were able to implicitly extract the use of a wider range of regular forms in everyday language.

Strong evidence that the children are learning the rule and generating new forms implicitly, comes from the overregularised errors. These are observed in the responses to the irregular forms on the TEGI past tense probe. Here the children are applying the regular past tense rule and adding the *-ed* ending to irregular verbs (e.g., eated /iːtɪd/ and drinked /drɪŋkɪd/) as automatically and quickly as they are to the taught items. It would be very unlikely that the children had heard these forms in everyday language in order to learn them as single lexical items. The majority of children (21/26) produced at least one overregularisation; all of these 21 children made gains on the Total past tense score after intervention and produced errors of overregularisation (mean 4.57,

range 1-8). The five children who did not produce an overregularised error are the same five who showed no gains following intervention.

This evidence suggests that the children who had learnt the rule were applying it in the more spontaneous task: the bespoke narrative retell task. Therefore, it appears that the explicit teaching of the regular rule, that does not rely solely on implicit learning, has been effective. According to the procedural deficit hypothesis, abnormalities in the brain structures associated with the implicit procedural memory system are responsible for the difficulties with grammar seen in children with DLD (Ullman & Pierpont, 2005) and possibly children with DS. However, the findings in the current study suggest that that the explicit teaching has resulted in the children being able to mark novel forms quite implicitly. The ease at which errors of overregularisation occurred (without considerable concentration, time or consideration) supports this automatic use of rule-like knowledge. An alternative view to the deficits in procedural memory is a deficit in declarative memory. Whilst the declarative memory system seems to be relatively capable of associating meaning to some monomorphemic words, it appears to have more difficulties with others. Verbs are more challenging as extracting the meaning of a verb relies on hearing the verb and the surrounding words (the syntactic frame) and then retaining the syntactic frame in the phonological shortterm memory. Individuals with DS are reported to have difficulties with hearing and verbal short-term memory which increases this challenge. This could explain the reported difficulties relating to verbs for individuals with DS. Taking this further, morphosyntax relies even more on these two areas of weakness. Grammatical morphemes are phonologically weak and semantically opaque. Therefore, they are the most vulnerable to being lost from the input that individuals with DS receive. If these forms are not heard and maintained in the phonological loop, then the declarative memory system cannot add them to the lexicon (add the associated meaning and phonological form(s)).

It may be the case that, rather than children with DS having a specific difficulty with implicit learning, other factors (e.g., hearing impairment and phonological short-term memory difficulties) could be barriers to the ability to use a relatively intact implicit system. One author suggests that implicit learning is somewhat intact for individuals with DS (Rondal, 2017) as evidenced by their ability to learn and use relatively simple

utterances consistent with the rules of the language. Rondal (2017) suggests that it is the necessity to relate units in longer utterances, that often occur in nonadjacent position, that impede implicit learning in DS.

The majority of children with DS have difficulty hearing and retaining complete utterances in phonological short-term memory. This possibly results in degraded utterances being maintained in the phonological short-term memory with the most vulnerable parts of the utterance often being lost. The most vulnerable parts of the language are those with reduced salience and more ambiguous links to meaning (e.g., Grela & Leonard, 2000). This makes it much more difficult to notice the implicit grammatical patterns in the language environment over time and extract the grammatical rule. The end result may be that these grammatical morphemes are not stored with the associated phonological form(s) and meaning. The intervention explicitly taught the RSPT morpheme, both the various phonological forms and their meaning. The teaching made use the orthographic form ("ed") with the rationale that this visual cue is less transient and so would compensate for poor phonological shortterm memory associated with DS. This may have given the children the opportunity to add this grammatical morpheme to their lexicon. Once there, they are able to access and use this knowledge according to the relevant grammatical rule. It is important to note that the intervention included lots of opportunities for the children to extract and use the rule for regular past tense formation. This may at least partly explain the gains made from the intervention. If so, it would suggest that the deficits in phonological short-term memory in children with DS can be supported to work more effectively with some explicit teaching.

The generalisation of the explicitly taught grammatical rule appears to have given rise to rule-like knowledge that can then be retrieved without explicit or conscious awareness. If this is true it casts doubt on the usefulness of the procedural learning account which argues that both (1) the learning processes underlying the abstraction of grammatical rules and (2) the resulting knowledge that supports language production, depend on implicit (unconscious) systems. It appears that learning the rule explicitly can result in implicit use of the RSPT in children with DS.

9.2.1.2. Other tense morphemes

Whilst the intervention generalised the use of the RSPT morpheme -ed, the second research question was concerned with any generalisation to other tense morphemes. The TEGI third person singular probe was used to elicit a comparable bound tense morpheme. The children were scoring similarly low scores at t1 on the third person singular morpheme which is in line with previous research (Eadie et al., 2002; Laws & Bishop, 2003). At t2, the intervention group had made no significant gains on this second tense morpheme. This shows that they are not generalising an understanding of the grammatical contrast of tense, rather they have learnt one grammatical rule. This rule was taught very explicitly and led to the children being able to generalise this rule quite implicitly to untaught verbs and further still to irregular forms. However, the fact that no generalisation to other tense morphemes took place, suggests the children with DS in this study master tense in different ways to typically developing children.

It should be noted that the third person singular is more complex, as it combines grammatical information relevant to both tense and agreement and is acquired later than the RSPT for typically developing children. If the explicit teaching of the regular past tense rule had enabled the child to implicitly extract the pattern of other grammatical morphemes, the third person singular might be acquired later. No further gains were seen at t3 for the intervention group 12-14 weeks following the intervention, however observation over a longer period of time could be informative. Comparison to the use of another form of past tense (e.g., the auxiliary *the boy was running*) was considered but disregarded due to the periphrastic nature of the tense form required. Unfortunately, it was not possible to collect the data to explore a range of other tense morphemes (e.g., past continuous, present continuous) due to the length of assessment required, discussed in Chapter 4 (4.5).

This lack of progress on another tense morpheme, suggests that explicit teaching of other grammatical morphemes and the associated rules may be beneficial for individuals with DS. The intervention did not teach the children the rule for the third person singular -s, so potentially this grammatical morpheme is still not stored in the lexicon with any meaning attached. It is hypothesised, that if a similar intervention (using explicit and implicit strategies) were to teach another grammatical morpheme, developing the child's understanding and use of a grammatical rule, this too could be

successful. This would suggest that all grammatical rules may need to be taught explicitly for children with DS to acquire mastery.

9.2.1.3. Irregular simple past tense

Although irregular verbs emerge early in typical language development, they are then replaced with regular verbs and errors of overregularisation, while children master the RSPT rule. In contrast to rule governed tense morphemes, it is thought that irregular forms are learnt as single lexical items like nouns (e.g., Bybee & Moder, 1983). Therefore, in order to learn an irregular verb, the child has to add this item to their lexicon using their declarative memory system. This requires the necessary number of repetitions to make the link between the spoken form and the verb. In the TA training, any use of irregular verbs by the child in spontaneous language (as these were not included in the intervention) was covered; if the child produced an overregularised error in everyday language, the training recommended the TA responded by telling the child that the word is an irregular verb and it doesn't follow the rule and modelling the correct irregular form. As discussed above regarding the RSPT, to learn irregular verbs the child must hold onto the syntactic structure to extract the required lexical information and link the relevant syntax and morphosyntax to extract this information. If children with DS have difficulties hearing and retaining this information in their phonological short-term memory, this will have the same negative impact on acquiring irregular verbs. The intervention did not target any irregular verbs, therefore the children were not exposed to the required repetitions using the explicit and implicit strategies embedded to teach the RSPT. Therefore, this lack of generalisation to correct irregular forms was expected.

9.3. What factors may contribute to improvements?

Following the effectiveness of the intervention in generalising the regular past tense rule, the possible contributing factors are discussed including baseline measures, factors associated with the intervention delivery and design, as well as any phonological and linguistic factors.

9.3.1. Baseline measures

A number of baseline measures were correlated with the gains made in the use of the RSPT following intervention.

Chronological age did not correlate with gains made in the use of the RSPT. However, nonverbal mental age correlated significantly with these gains. This raises the possibility that the children with higher nonverbal mental ages were able to make greater improvements in terms of the intervention. The fact that nonverbal mental age correlated with all baseline measures suggests that a child with DS with a higher mental age is generally scoring higher across all measures of language and literacy. This is of course the pattern seen in typically developing children. However, the baseline measures show some atypical discrepancies for children with DS. For example, receptive grammar is significantly lower than receptive and expressive vocabulary scores. When nonverbal mental age was controlled for, significant correlations were still observed for word reading, letter sound knowledge, RAPT information and to a lesser extent receptive vocabulary.

The highly significant correlations between the literacy measures (word reading and letter sound knowledge) and the gains on the intervention (after controlling for nonverbal mental age) are noteworthy. The intervention used a number of implicit and explicit strategies including the use of orthography. This was due to previous studies supporting the use of orthography when targeting the learning, comprehension and memory of spoken vocabulary and language. Given the reported difficulties for individuals with DS in hearing and the reduced salience of these forms, orthography could potentially provide an additional visual support for developing the awareness of these morphemes. Further, given the difficulties with phonological short-term memory, the use of orthography could reduce the demands on this system. By giving the child the orthographic form, they would potentially not be solely reliant on phonological short-term memory to repeat the sentence the TA modelled. Rather they could use the text to visually aid this practice. Reading more complex and grammatically correct sentences has been argued to support gains in the use of grammatical morphemes of individuals with DS in previous research (Buckley, 1993). Furthermore, this visual orthography could potentially support the development of accurate phonological representations that are known to be a specific challenge (e.g., Jarrold et al., 2009).

Buckley (1993), argues orthography is also beneficial for those individuals with DS who have lower reading scores or are non-readers. The intervention in the current study went further than simply providing the orthography. The children were required to write the sentences, thus requiring them to explicitly consider how the rule impacts the form of the verb. The TAs were required to support this consideration with prompt questions such as what do you need to add if its finished/in the past? and why did you add -ed? supporting the child's understanding of the meaning associated with the morpheme. (For those children who were unable to write, multiple copies of the verb stems and the morpheme were provided separately, for the child to physically combine.)

Whilst this activity has potential benefits for readers and non-readers, the better readers would presumably be at an advantage if they could already read the prompts and make use of their letter sound knowledge. However, the highly significant correlation between the literacy scores at t1 and the gains in the use of the RSPT at t2 cannot be used to establish any causation. Therefore, whilst a number of baseline measures correlated with gains following intervention, future research is needed to explore causal relationships.

9.3.2. Factors associated with the intervention delivery and design

The intervention was designed to evaluate the effectiveness of a realistically viable intervention that could be replicated in the future. One of the criteria for participating was that children were attending mainstream school. The reasons for this included that children with DS in the UK typically receive a high number of hours of adult support (e.g., over 30 hours per week) (Hargreaves et al., 2021). Given the duration and intensity of previous effective interventions (e.g., daily (Monday-Friday) sessions, lasting 15-40 mins over the course of 15-20 weeks), the use of TAs make this model feasible if effective. Previous research has found TAs to be effective in delivering language and literacy-based interventions to school age children with DS (e.g., Burgoyne et al., 2012a; Goetz et al., 2007). Further, TA effectiveness has been shown to correlate with intervention gains for children with DS (e.g., Burgoyne et al., 2012a).

The current intervention included observations of the TA delivering the daily intervention session approximately every two weeks, during the 10-week block. During

the observation the SLT completed an observation record sheet and made notes regarding four criteria relating to session delivery; 1) organisation, which included adhering to timings, having resources ready, knowledge of the session plan, 2) tailoring to individual's needs, which included providing too little/too much support, ensuring the child was actively involved in the activity, 3) compliance, how closely the TA was adhering to the intervention e.g., delivering the correct activities, using the intervention language, 4) behaviour management, how well the child was supported to complete activities. In line with the previous research (e.g., Burgoyne et al., 2012a), the current study found measures of TA delivery to significantly correlate with gains on the use of the RSPT. Furthermore, closer exploration of the data showed the five participants who made extremely low or no progress had worked with the TAs with the lowest scores. Again, no causation can be inferred from this correlation, but future research should explore any associations between the two.

Training obviously plays an important role in equipping TAs (or non-SLTs) to deliver language interventions effectively. The current intervention included a training day in the two weeks ahead of the start of the intervention block as well as observations with feedback every two weeks. In addition, the TAs had access to email and telephone support. The overall TA scores from the first two weeks of delivery of the 10-week intervention and the final two weeks of delivery were compared. The scores from the final weeks of the intervention were significantly higher than those from the first two weeks. This indicates that the quality of the TA session delivery continued to improve overall across the 10 weeks. Whilst the feedback and support are potentially contributing to this, other factors may also be contributing. The intervention followed the same structure each week, so that children would become familiar with the activities and the strategies. This familiarity could potentially start to benefit the child through repetition of the patterns of marking the RSPT in the activities. This would no doubt have resulted in the TAs also becoming more familiar and confident with the format of delivering the activities.

In addition, the TAs were invited to complete a questionnaire asking for feedback on the intervention. They scored the training and the manual highly in terms of being prepared and supported to deliver the intervention. TAs were invited to give qualitative feedback about delivering the intervention. Comments were positive in terms of the clarity of the manual and the resources. One TA commented *very clear manual, if I'd lost the manual, I wouldn't have known what to do*, highlighting the importance of clear ongoing instruction.

When asked to feedback on the child's most and least favourite activity, far more activities were reported as most favourite. The activity that was most frequently reported as least favourite was the video write up. This activity involved the children watching the video from the previous day and writing up what they had done (e.g., writing a postcard to someone). TAs were invited to comment on each activity and the comments regarding video write up frequently included the child not enjoying writing. Interestingly, the training and observation visits frequently fed back that the child only needed to write the RSPT -ed and not the whole sentence (i.e., the child was required to add the required morpheme and answer the question prompts regarding why). Further, typed words and morphemes were provided for all children to overcome the difficulties with writing. The decision to include more writing was made by the TAs. One reason for this is potentially the child(ren) did not enjoy writing, but the TA felt this was an appropriate goal for the child.

The activity rated most favourite was the video recording activity. In this activity the child was required to 'act out' a structured sequence of the four verbs for the week (e.g., making a playdoh pizza involved squeeze, roll, chop and cover). This activity was also reported most frequently as the one that produced the most use of the target RSPT morpheme by the child. This activity was particularly associated with the intervention strategy; links to own experience. The intervention was designed to encourage the child to use the RSPT target to talk about themselves and their experiences. For example, the video recording activity allowed them to watch the video and then talk about what they did, the video was the then used the following day to talk about what they did the day before. On a Friday, the child was required to review all the resources they had developed that week and talk about what they had done that week. Whilst there is limited previous research to support this personal activity review for individuals with DS (e.g., Finestack et al., 2017), it was considered an opportunity to practise the use of the regular past tense in everyday language. Importantly, the overall target of the intervention was for the child to be able to use the RSPT to communicate in everyday language. In addition to the personal experiences

in this activity, the use of the regular past tense was targeted in a range of other contexts. The use of multiple contexts has been associated with positive effects in previous research targeting grammatical morphemes (Sepúlveda et al., 2013).

The intervention involved a number of implicit and explicit intervention strategies. Interventions that combine these two have been shown to be effective for developing grammar in children with DLD (e.g., Calder et al., 2021; Ebbels et al., 2007) and children with intellectual disability including those with DS (e.g., Bibi et al., 2019; Tobin & Ebbels, 2018). The methods used in this current study, included; use of modelling and imitation, frequency of modelling in context, ideal listening conditions, use of orthography to support the spoken form, duration and intensity, use of trained TAs and regular SLT visits, explanation of grammatical rules. Several of these have been discussed above due to their involvement in the activities rated most frequently by TAs.

The following methods were all implicit strategies included generally throughout all intervention activities; ideal listening conditions, modelling (which was provided at a high level of frequency), and modelling in a range of contexts/activities. The TAs were instructed to find a quite space to deliver the intervention. This was to ensure the best possible listening conditions for the child. Children with DS experience a high level of hearing difficulties and 34.2% of the children in this study were reported by their parents as having a current hearing impairment. Due to the regular past tense morpheme being phonetically weak, it was advised to provide a quiet environment to reduce background noise. This would potentially provide ideal listening conditions for the child to hear the phonological form modelled by the TA. In addition, additional memory load (in the form of additional verbiage), has a negative effect on verbal short-term memory for typically developing children who do not have difficulties with hearing and phonological short-term memory (Hayiou-Thomas et al., 2004). Thus, the difficulties with phonological memory associated with DS were further rationale for this quiet environment.

The training and manual gave clear instruction about the high level of modelling required by the intervention and the manual provided example scripts for the TA for each activity. As all activities included this high level of modelling, this was provided across a range of contexts (e.g., stories, role play, video and video review etc.).

Interventions that use only implicit strategies such as recasting have been found to be successful for children with language delays (see Cleave et al., 2015 meta-analysis for review). Recasting has been reported to have some success for children with DS (Camarata et al., 2006) although gains and sample size were limited. Evidence for interventions that use implicit and explicit strategies have also been reported to show gains for children with DLD (Calder et al., 2021; Smith-Lock et al., 2015). Smith-Lock et al. (2015) compared the use of recasting alone to a combined explicit rule instruction with systematic cuing (providing increasing scaffolding up to the level of requesting repetition). Significant gains were found for the combined intervention over the use of recasts alone. Similarly, interventions that include modelling and imitation have shown gains in morphosyntax for children and adolescents with DS (Buckley, 2003; Sepúlveda et al., 2013). Therefore, the use of modelling and imitation was used in this current study.

In addition to imitation, a final explicit strategy was included; explanation of grammatical rules, with the support of orthography. The children in the current study were not simply told the correct forms of the verbs in the past tense, rather they were taught that *-ed* is added to the end of verbs when the action had finished. The intervention activities required the child to physically add the orthographic form *-ed* to the end of the verb (either writing or gluing it to the page). At the same time, the adult prompted the child to say why they were adding *-ed* (e.g., "why are you adding *-ed*?" – because it's finished/it's in the past).

As the intervention used both implicit and explicit strategies, it is not possible to say which was more effective. Similarly, it is not possible to say which of the individual seven strategies was most/least effective in producing the intervention gains. It remains for future research to explore these factors and to try to determine which were the most crucial to the intervention. All that can be concluded is that an intervention that included all these strategies, effectively improved the use of the RSPT for a group of children with DS.

Finally, in addition to the scoring and feedback from the TA, the child was scored during the intervention in terms of their enjoyment, how much the child was engaged in the session. This score was significantly correlated with the gains on the use of the RSPT. Again, no causation can be inferred but this information and the feedback from

the TA questionnaire (including the higher number of most favourite activities and the positive comments) suggest the intervention was engaging to the child. It is potentially important that the child is engaged in the activities to support progress and generalisation.

9.3.3. Phonological and linguistic factors

It is well established in the literature that phonological and linguistic factors impact morphosyntax for typically developing children (Whan Cho & O'Grady, 1997). Those morphemes that are phonetically weak and semantically opaque tend to be acquired later. It is unknown how these factors impact individuals with DS. The gains on the intervention were analysed to explore if there were any effects of phonological form or association with the order the verbs are typically acquired in English.

All 60 verbs (40 taught from the TRSPTP and the 20 untaught from the URSPTP) were coded for phonological form (e.g., /d/, /ɪd/ or cluster). The number of children who successfully marked the RSPT on each of these 60 verbs at t3 (once all children had received the intervention) was calculated.

There was a significant difference between the /d/ (e.g.,cried /krʌɪd/) form and the /ɪd/ (e.g., waited /weɪtɪd/), and a significant difference between the /ɪd/ (e.g., /weɪtɪd/) and the cluster form (e.g., crawled /kroːld/). There was no significant difference between the /d/ or cluster forms. This is in line with previous research that shows the /ɪd/ form emerging later for typically developing children (e.g., Berko, 1958; Brown, 1973). One potential factor for this is that the /Id/ form requires an additional syllable which potentially increases the articulatory demands. A second potential factor is that the /ɪd/ form occurs less frequently in English. This is reflected in fewer of these forms being included in the intervention (taught and untaught). Therefore, the children have potentially had less practice of these forms. Finally, this form is required when the verb stem ends in an alveolar consonant (e.g., /t/ or /d/), which are the other two forms of the RSPT. Thus, the additional syllable has to be added to a verb that already ends in a potential RSPT ending, which is considered to add resistance (e.g., Marchman, 1997). Any of these factors (separately or together) could account for the significant differences between this form that requires an additional syllable and the other two forms. The children received less explicit teaching of this form of the regular past tense. Therefore, the form of the additional syllable, has potentially not yet been linked to the representation of the regular past tense *-ed* in the lexicon. It is possible that more repetitions (perhaps the equal number of repetitions that the other two forms received in the intervention) could impact the gains of this form of the regular past tense. This evidence somewhat conflicts the declarative/procedural model (Ullman, 2001) which argues that if the children had acquired the rule, they should apply it to all phonological forms. This is not the case for the additional syllable suggesting that phonological form does play some role as argued by other phonological accounts.

Previous research has found that the addition of /d/ following a vowel is acquired earlier than those that require a cluster (e.g., Marshall, 2005; Oetting & Horohov, 1997). However, this study found no significant difference between these two forms at t3. Many of the children had made significant gains by the end of the 10-week intervention, and ongoing progress (during the 10 weeks) on the various forms was not recorded.

Previous research has also shown that the increasing number of consonants within the cluster used to mark past tense, negatively impacts RSPT marking (Marshall & van der Lely, 2006). Whilst the high number of verbs allowed a large range of consonant clusters, these clusters were not compared in terms of their success. Almost all of the phonological forms requiring clusters, included two consonants in the cluster (e.g., crawled /krɔːld/ and hopped /hɒpt/) with the exception of two which required three (e.g., mixed /mɪkst/ and jumped /dʒʌmpt/). This was due to the verbs being chosen from words that occur relatively early in language development (taken from the DSEI checklists (2009) documenting the first 810 commonly used vocabulary items). Future research should explore any relationship between the phonological form and earlier progress during the intervention. One possibility would be to add an assessment of a range of forms as part of the observation visits.

The checklists used to predominantly select the verbs allowed comparison between the number marked correctly at t3 and the checklist they occurred on (54 verbs were taken from the checklists, the six additional verbs used in the intervention (four taught and two untaught) were excluded from analysis). These early acquired verbs were chosen as the intervention was focussing on teaching the grammatical rule and any additional demands such as verb/word learning could potentially distract or impede

the focus. Thus, verbs that emerge early were potentially more likely to be known by the child. However, each child's knowledge of these 54 verbs was not assessed preintervention. There were no significant differences in verbs from the three different checklists. The fact that many of the verbs may have already been known may potentially account for this. Future research could compare verbs that occur in low and high frequency to explore any association with RSPT marking.

9.4. Preintervention, what difficulties with morphosyntax/tense were the children experiencing?

As a large amount of data had been collected on the use of the participants' morphosyntax at t1, it was used to explore the nature of these difficulties and compare the findings to previous research. Although there is considerable agreement that children with DS have difficulties with morphosyntax in general (e.g., Bol & Kuiken, 1990; Chapman et al., 1998; Eadie et al., 2002; Laws & Bishop, 2003), the evidence concerning the nature of these difficulties is limited. A few studies have compared tense and non-tense morphemes (e.g., Chapman et al., 1998; Eadie et al., 2002; O'Neil & Henry, 2001) and a few have compared regular and irregular past tense (e.g., Eadie et al., 2002; Laws & Bishop, 2003; Ring & Clahsen, 2005). A group of children with DS (mean age 7;2 years) were reported to be scoring significantly lower on a nontense composite measure when compared to younger typically developing children matched on nonverbal mental age (Eadie et al., 2002). Further, the authors reported no significant difference between the two groups on a composite measure of tense. However, significant differences were reported for the individual tense morphemes; RSPT -ed and third person singular -s. Chapman et al. (1998) also report high omissions of tense morphemes (regular simple past and third person singular) for individuals with DS (mean age 12;5 years) and lower omissions of the regular plural. A similar conflict is found regarding the use of regular and irregular past tense verbs with some authors reporting equal difficulty with both (e.g., Ring & Clahsen, 2005) and others reporting a relative strength regarding irregular verbs (e.g., Eadie et al., 2002; Laws & Bishop, 2003). Therefore, the opportunity to add to this literature using the data gathered at t1 was fortuitous.

This data gathered at t1 allowed some exploration of the use of the RSPT compared to the non-tense morpheme regular plural -s. It also allowed comparison of the RSPT to the irregular forms on the TEGI past tense probe.

9.4.1. Comparison of tense and non-tense

The RAPT was analysed for grammatical morphemes that could be considered produced in obligatory contexts. The children all achieved low scores on the measure of receptive language at t1 which is typical of children with DS (e.g., Chapman et al., 1991; Næss et al., 2011). Given the extent of these difficulties, it was decided that question probes used by the RAPT would potentially not be understood. Therefore, the questions could not be considered obligatory context for morphosyntax. This resulted in the RAPT being used as essentially a picture description exercise. In order for obligatory context to be obtained, the picture had to clearly represent and require the use of a specific morpheme. Obligatory contexts were provided most frequently for the regular plural -s. Given some studies have reported a difficulty for individuals with DS in the use of the regular plural -s (Chapman et al., 1998; Ring & Clahsen, 2005), it was decided that a comparison with previous findings would be useful.

The regular plural -s was compared to the use of the RSPT in obligatory contexts. In order to achieve this, the responses on the TEGI past tense probe were scored for the use of the RSPT in obligatory contexts. Whilst the format of the TEGI met the criteria for obligatory context at the discourse level, a caveat was added; any responses that included the correct use of an alternative tense were excluded. These utterances were considered evidence that the child had potentially not understood the format of the test and had intentionally used an alternative tense (e.g., present progressive *the boy is raking*).

There was a highly significant difference between the use of the regular plural and the regular past tense at t1. The median score for the regular plural was 100% with 33/51 participants obtaining this score. In contrast, the median score for the regular past tense was zero, with 34/51 obtaining this score. Therefore, the evidence quite clearly suggests that children with DS have significantly fewer difficulties with the regular plural -s compared to the RSPT -ed. It is important to note that there were far fewer obligatory contexts for the regular plural and this should be kept in mind when

interpreting the results. This evidence rather supports the words and rules theory (Pinker, 1999) which suggests that once a grammatical rule is acquired it is used relatively consistently. However, in terms of the phonological deficit hypothesis is raises the question as to how the procedural memory system has relatively successfully learnt the rule for the regular plural but not for the regular past tense. This evidence suggests that some grammatical morphemes are more vulnerable than others due to a number of phonological and linguistic factors discussed in Chapter 3. Those that relate to nouns for example (e.g., plural -s, possessive -s) take a number of phonological forms but are relatively straight forward and consistent in terms of links with meaning (e.g., plural -s either occurs or does not occur depending on number). The hearing and phonological short-term memory difficulties could mean that bound morphemes are at risk of not being heard and retained by the phonological loop to allow the child to extract the pattern of use. Due to the relatively straight forward and consistent use of the regular plural, when it is successfully maintained, it is relatively easy to extract the pattern. Therefore, children with DS are potentially more likely to acquire morphemes that are relatively more straightforward in terms of form and meaning and have fewer conflicting forms. This is true for typically developing children who also acquire these morphemes earlier.

The tense morphology relating to the past is less straight forward and consistent as the verb takes a number of different forms (e.g., the bare form *crawl* in first person simple present tense as in *we crawl*, the form inflected for the RSPT *crawled*, and the past progressive form also used to reflect past tense with the auxiliary *was*). Furthermore, in order to identify the pattern of use, the child must rely much more heavily on the surrounding syntax which is more complex for verbs (e.g., Black & Chiat, 2003). Previous studies suggest that it is the difficulty extracting the meaning from the surrounding syntax that is responsible for the difficulties with verbs that are experienced by children with DS (Hesketh & Chapman, 1998). Furthermore, Rondal (2017) has suggested that the difficulty retaining syntax and morphosyntax (in the phonological short-term memory) is responsible for the difficulties in extracting morphosyntax.

One point of interest is the observation that the children do not appear to overgeneralise the rule for the regular plural to irregular forms (e.g., sheeps /[i:ps/).

There was only one example of the irregular plural targeted in the RAPT (e.g., *mice*). A total of 16 children produced this irregular plural *mice*, as the bare form *mouse*. Only two children produced the overregularised error (i.e., *mouses* /mausiz/). A more frequent use of the bare form for irregular plurals compared to regular plurals has been reported in previous research. Ring & Clahsen (2005), report approximately double the number of bare forms for irregular plurals (31.5%) than regular plurals (16.6%). It is unfortunate that they provide no information about overregularisation so it is unknown whether their sample included any examples of these.

9.4.2. Comparison of regular and irregular past tense

The TEGI was used to compare the use of the RSPT to the use of the irregular, both in obligatory context. The PCOC scores for the irregular forms of the TEGI were scored using the same criteria as the regular forms discussed above (i.e., responses that included the correct use of an alternate tense (e.g., the present progressive) were excluded rather than scored incorrectly). There was no significant difference in the children's use of the two past tense forms; both were rarely produced by the majority of children (e.g., median score zero for both forms, 34/49 scored zero for the regular form and 35/49 scored zero for the irregular form).

This low scoring on both forms is contradictory to some previous studies (e.g., Eadie et al., 2002; Laws & Bishop, 2003). The Laws & Bishop study (2003) used the same measure (TEGI), however their participants were potentially dissimilar to the participants in the current study in a number of ways. Firstly, the participants were older which could potentially account for these higher scores. Perhaps given more exposure to the language the children would learn these forms as single lexical items. Secondly, they report that they excluded individuals with DS who had hearing loss. Given the high number of children with DS who have hearing difficulties and hearing loss has been associated with language difficulties (e.g., Laws & Hall, 2014), this potentially skews their sample. If the children with current hearing impairments (as reported by parents) were excluded from the current study, the number of participants would be reduced by 34.2%. Finally, the authors report excluding five participants from the original cohort who did not understand the instructions for the test. However, they provide no information on how this understanding was assessed. Potentially, these participants did not produce any past tense verb forms although no obligatory

context is discussed (scoring was calculated as percentage of correct use, omission errors are discussed but not numerically reported). They conclude that the participants with DS have a relative strength in irregular verbs as they are not significantly different from the controls matched on nonverbal mental age (mean age 5.9 years). However, the means are widely different (mean percentage of correct use for DS = 21.4, typically developing = 40.9) and standard deviations for the individuals with DS are larger than the means on all measures of tense (regular, irregular and third person singular). Furthermore, the means and standard deviations for the individuals with DS are similar for percent of regular past tense forms correct (29.2 (29.9)) and irregular correct (21.4 (25.2). This suggests that the participants were not performing better on irregular forms compared to their own regular forms.

The Eadie et al. study (2002) similarly reported no significant difference between the children with DS and the typically developing group matched on nonverbal mental age when comparing the use of the irregular past tense. They also reported no significant difference in the use of irregular past tense between the younger typically developing group and a third group with DLD which is contradictory to the literature regarding DLD (e.g., Rice et al., 2000; Rice et al., 2002). Eadie et al. (2002) collected language samples in play. All participants with DS were reported to produce at least three examples of irregular past tense in obligatory context. However, it is not possible to ascertain whether the child was producing a range of irregular forms or the same one three times. The mean number of irregular verbs used is reported for the entire group of participants, but not for the separate groups. Therefore, no conclusions can be drawn from this study in terms of the range of irregular forms used. Similarly, the comparison to the young nonverbal mental age matched controls (mean 3;3 years) rather than their own regular past tense forms is potentially misleading.

The current study is in line with the findings of Ring & Clahsen (2005), who reported older children with DS (age 12-14 years) scored equally poorly on an elicitation task specifically comparing regular and irregular forms. This is comparable with the current study which showed children had similar difficulties with both regular and irregular verb forms, and these difficulties were experienced relatively equally across both forms.

A very small number of regularised errors (overgeneralisation of the RSPT rule e.g., /drɪŋkt/) were observed at t1 (see Table 12). This overgeneralisation, which suggests

some awareness of the RSPT rule for these individuals, is in line with previous research (Ring & Clahsen, 2005; Laws & Bishop, 2003).

Given that children with DS are reported to have a strength in vocabulary (and this is observed in the current study), it might be expected that children would have a relative strength in irregular forms. This expectation would be due to irregular forms being learnt as single lexical items like nouns as has been suggested for children with DLD (van del Lely & Ullman, 2001). The children in the current study have an expressive mean vocabulary age equivalence of 5;1 years. Therefore, if the children's expressive vocabularies were following the same pattern as typical development, they would be expected to have acquired a range of irregular verbs by this stage. It appears that the children do not show a relative advantage for acquiring irregular verbs as single lexical items. It therefore suggests that individuals with DS have a difficulty with tense more generally and throws doubt that deficits in the procedural memory system are solely responsible for the difficulties with grammar.

The difficulties regarding acquiring verbs discussed previously, will of course impact regular and irregular verbs; the syntactic frame must be heard and maintained for the lexical information to be linked to the syntax and morphosyntax. The relative phonological and semantic information can then be extracted and stored. This presumably happens over time and could potentially, at least in part, be considered to be learnt implicitly (via the procedural memory system). Verbs are then more challenging due to these syntactic challenges. Furthermore, it is suggested that verbs are more challenging to learn due to the many different phonological forms they take. For an irregular verb such as eat, there are numerous forms depending on the utterance structure (e.g., the bare form eat, the irregular simple past tense form ate, as well as the progressive form that occurs with the auxiliary was). The evidence from this study suggests that children with DS have similar difficulties with irregular and regular past tense marking.

9.4.3. The use of regular and irregular tense at t1 for participants using the tenses more frequently

Whilst the use of regular and irregular forms was limited for the majority of the children at t1, some participants did produce past tense forms. At t1, there were nine children who marked either four or more regular past tense forms correctly and/or three or more

irregular past tense forms correctly. The past tense marking by this group of children was used to explore any patterns.

In typically developing children, tense evolves in a U-shaped pattern of development that involves four stages (e.g., Brown, 1973; Blom, 2018). Stage 1, regular and irregular verbs are used in their bare form. Stage 2, high frequency regular and irregular forms are used and at this stage these are thought to be learnt as single lexical items. Here the child has not yet discovered the regular rule. High frequency verbs are commonly used at this stage and many of these are irregular. Stage 3, the regular rule begins to emerge, at this stage regular past tense forms are frequently produced correctly and overregularised irregular forms occur. Stage 4, the child returns to using a range of regular and irregular forms correctly, although irregular errors on novel forms continue (Shipley et al., 1991).

The data from the nine children using some past tense forms shows a range of performances on the past tense items. When interpreting this data, it should be kept in mind that the TEGI only targets elicitation of 18 verbs in total (10 regular, eight irregular). Four of the nine children are producing regular and irregular forms. One interpretation of this could be that the children are in the first stage of past tense development; they produce some regular and irregular forms as learnt single lexical items. However, all four produced at least one overregularised error, which is uncommon until stage three. In stage three, errors of overreguarisation are common but also correct use of regular past tense forms so perhaps this is more likely. Here they are using tense inconsistently like typically developing children do in the optional infinitive stage (Wexler, 1994). In contrast, four other children only produce regular forms which is atypical of any stage but perhaps suggests these are learnt single items. However, one of these children produced one overregularised error at t1 suggesting some awareness of the rule. Finally, one child produced only irregular forms, but one regularised error. This child's performance seems particularly atypical. The overregularised error suggests some awareness of the regular rule has been learnt, however the failure to mark any regular forms is contradictory.

This data is obviously limited, however given the lack of studies exploring the acquisition of morphosyntax (e.g., Rutter & Buckley, 1994) the minimal use by these participants is of interest. The data suggests some of the children were starting to

develop tense morphology implicitly. In addition, three children were excluded from the intervention as they were already showing some consistent use of tense. Due to the lack of targets around morphosyntax reported on the family background questionnaire (only 2 participants were working on morphosyntax), it is potentially unlikely that these children have been taught the rule explicitly. Therefore, this suggests that some individuals with DS do acquire some morphosyntax relating to tense without intervention. However, the literature suggests this is the minority and that many individuals continue to omit tense into adulthood without intervention (e.g., Chapman et al.,1998).

As outlined in Chapter 4 (4.4.2.3), the declarative/procedural model claims that the lexicon is dependent on declarative memory. The lexicon includes words learnt as single lexical items (e.g., monomorphemic words including irregular forms), bound morphemes (e.g., grammatical morphemes, suffixes etc) and structures where the meaning is not easily derived (e.g., idioms). In contrast, grammar is thought to be dependent on procedural memory which is associated with the sequential combinations required by syntax and morphosyntax. The procedural deficit hypothesis argues that abnormalities in the brain structures that underly the procedural memory system are responsible for the difficulties with morphosyntax as experienced by children with DLD (Ullman & Pierpont, 2005).

9.5. Summary and conclusions

9.5.1. Implications for future research

Given the intervention included a combination of implicit and explicit strategies, it is not possible to identify whether implicit learning or explicit learning was associated with the gains. Alternatively, both strategies may be required for an intervention such as this for children with DS. It is not possible to provide intervention without some implicit strategies (e.g., modelling), however future research could explore an intervention that combines implicit and explicit strategies to an intervention that uses implicit strategies alone.

Following on from the suggestion that the intervention has strengthened a representation for the RSPT morpheme in the lexicon, future research could explore other grammatical morphemes. Would a similar intervention that targets the third person singular -s find comparable gains? Given the effectiveness of the current intervention, this seems highly possible.

Future research could also explore the required duration and dosage of intervention to facilitate gains. The current intervention consisted of a 10-week block of daily 20-minute sessions. Significant gains were seen for both the intervention group and the delayed intervention group following the 10-week block. However, it is unknown what gains were made part way through the intervention. The evidence from the data regarding the /ɪd/ form, suggests there was not sufficient exposure to this form to bring about the same gains. Therefore, intervention that explores an ideal duration and dosage for intervention would be appropriate.

Future research could also explore whether gains extend to everyday conversation and will need to consider the best method for eliciting these samples. In retrospect, one method could include videoing the child completing a number of untaught actions matched to the taught verbs. The child could then watch the video and once the video is finished, be asked to retell what they did. This would use the familiar format of one of the weekly activities to support understanding of the task and potentially produce a more spontaneous language sample to observe any use of the use of the past tense

It would also be appropriate for future research to explore the reasons behind the lack of gains for some individuals. Would a longer intervention bring about improvements for this group or are there other factors at play? The fact that the TAs who delivered the intervention to this group of children scored the lowest overall TA scores needs further exploration. It would be beneficial to determine whether the lack of gains was linked to factors associated with the TA (e.g., confidence, compliance etc.) or factors associated with the individual children (e.g., hearing, short-term memory, speech). If it could be determined who would potentially benefit (or not benefit) from the intervention and why, alternative interventions could be considered.

One hypothesis for the difficulties with morphosyntax and the effectiveness of the intervention relies on the hearing and phonological-short term memory difficulties

associated with DS. Future research should explore these factors; do children with DS who have minor/no history of hearing loss and phonological short-term memories have better morphosyntax? Equally do those with less impaired current hearing and phonological short-term memory systems make more gains on the intervention? Also, which of these two factors is playing a more significant role or are they equally responsible? In addition, three children were excluded from the study as they already demonstrated relatively consistent use of the RSPT. Further research should explore whether the profile of this small group of children with DS differs particular in terms of hearing and memory.

Almost all of the verbs included in the current study that took the form of cluster when the regular past tense rule was applied, required two consonants. This did not allow for comparison of two clusters to those that required three clusters. Given this has been reported to impact the use of the RSPT in children with DLD, this could be explored in future research, particularly given the difficulties with speech experienced by individuals with DS.

The current study aimed to explore whether an intervention that targeted the RSPT in children with DS was effective. However, in doing so a considerable language sample was collected for a relatively large group. Given the limited evidence on the specific morphosyntactic difficulties, this was explored using the t1 data. Whilst limited, the evidence suggests that many of the children were not using irregular plurals nor overgeneralising the regular plural rule despite the majority of children using regular plural forms. Future research should explore this phenomenon, as this finding has been reported in previous research (Ring & Clahsen, 2005). These authors report approximately double the number of bare forms for irregular plurals (31.5%) than regular plurals (16.6%). It is unfortunate that they provide no information about overregularisation so it is unknown whether their sample included any example of these. It would be interesting to see why overregularsaion has occurred for the RSPT rule explicitly taught and not the regular plural rule implicitly learnt.

Finally, previous research suggests that children with DS have particular difficulties with verbs. Verbs are central to developing complex sentences and morphosyntax which are areas of difficulty for individuals with DS. Future research could focus on targeting the understanding and use of verbs in younger children with DS. If this

difficulty with verbs could be overcome through explicit (and implicit) teaching, the profile of difficulties associated with morphosyntax could potentially be altered.

9.5.2. Limitations

One of the biggest limitations of the intervention was the lack of robust measures of hearing and phonological short-term memory at t1. Information regarding current hearing levels and history of hearing loss was gathered through the family history questionnaire. However, this information was limited. Given that history of hearing loss has been associated with language difficulties in DS, parental interview may have gathered more specific and clear information. In addition, hearing test on the day of assessment would have provided a better measure of the participant's hearing at t1. However, given the fluctuating conductive hearing loss associated with DS and that the t1 assessments took pace just before the winter (when infections and glue ear are most common), it is unlikely to have been a true reflection of the participant's hearing throughout the intervention.

The second limitation of the study is that the assessor was not blind to the participant group. Future research could seek to replicate this study with a larger number of participants and assessors should be blind to participant group at all timepoints. However, given that it was not possible to be blind to participant group in the current study, interrater reliability measures were taken and excellent between observer agreement was demonstrated.

In designing the intervention, it was decided that short simple sentences would be used with a verb in final position. This was to reduce the hearing, phonological short-term memory and articulation demands for this group of children who have reported to have potential difficulties with all of these areas. Also, it made it easier for the assessor to judge whether the child had included the RSPT morpheme. However, this led to the use of some transitive verbs being used in an incomplete and unnatural way without an object (e.g., the lady collected), even though the object was illustrated (e.g., leaves). On reflection, the omission of these objects after transitive verbs in the assessment and some intervention activities may not have been best practice. It would have been better to include the objects to provide models of more natural language.

Another limitation is that the intervention is narrow in focus, targeting one grammatical rule. It should be noted that previous intervention studies for individuals are extremely limited and suggest long durations (e.g., up to a year (Buckley, 1993)). In addition, limited information about the intervention or assessment used have been provided (e.g., Sepúlveda et al., 2013). Given the extreme deficits in morphosyntax reported for children and adults with DS (e.g., Chapman et al., 1998; Laws & Bishop, 2003) and that this was the first randomised control trial evaluating the effectiveness of an intervention of this nature, a narrow focus was considered more appropriate. The effectiveness of this relatively short and feasible intervention supports future evaluation of interventions that use the same combination of strategies to target a range of grammatical morphemes.

Finally, it was not possible to identify which of the implicit or explicit methods were directly responsible for any gains in the use of the RSPT. Whilst TAs were asked to complete a questionnaire regarding the activities, a better method may have been to directly ask them which implicit and explicit methods they thought were more effective in terms of the children learning the RSPT rule. Also, more specific training on these methods, with rationale, could have been included in the initial TA training. In addition, the SLT observations could have been scored for the child's most frequent use of the target morpheme. Even though these methods would not definitively identify the most effective strategies, they would give some indication of those that may have had the most impact. Then these could be explored in future research.

9.5.3. Summary

The main aim of the study was to evaluate the effectiveness of an intervention to teach the RSPT to children with DS. The intervention group made significant gains on a range of measures of the regular past tense compared to the delayed intervention group at t2. Furthermore, the delayed intervention group made similar significant gains at t3, once they too had received the intervention. This provides clear evidence that the intervention was effective. The second aim of the study considered any generalisation that may take place, if the intervention was successful. Children generalised the use of the RSPT to items not taught in the intervention. Furthermore, generalisation was observed regarding irregular verbs where there were significant gains in the use of errors of overregularisation. These findings have important

theoretical implications. These errors of overregularisation are thought to support dual mechanism accounts for language learning, such as the declarative/procedural model (Ullman, 2001) which is an extension of Pinker's "words and rules" theory (1999).

The profile of language associated with DS somewhat aligns with dual mechanism accounts such as the declarative/procedural model (Ullman, 2001). The relative strengths in vocabulary, on the surface at least, support the idea that the declarative memory system is working relatively well. It would appear then that the difficulties with grammar are potentially due to deficits in the procedural memory system. The data from the current study allowed the exploration of rule learning in children with DS; was it possible to teach a grammatical rule to individuals with DS? The effectiveness of the intervention and generalisation to untaught forms, particularly the overgeneralisation to irregular verbs, clearly demonstrates that it is possible.

The pattern of generalisation and overgeneralisation of the grammatical rule learnt, does not fully support the procedural deficit hypothesis. Once the children had learnt the rule for marking the RSPT, there was evidence that they applied it to untaught verbs and irregular verbs quickly and unconsciously. This suggests that the procedural memory worked relatively well once the rule was learnt explicitly.

The intervention included explicit and implicit strategies. The declarative memory system is associated with explicit learning whilst the procedural memory system is associated with implicit learning. It is suggested that the explicit strategies supported relatively weak declarative learning, by providing visual representations of morphemes that were hard to extract and retain and explaining the rule for marking the RSPT. Then the implicit strategies gave the children opportunities to extract and use the learnt rule in meaningful contexts using relatively intact procedural learning. Given the ability of the children to generate new forms implicitly (both untaught items and overregularised errors) following the intervention, it raises the question as to whether the difficulties with morphosyntax associated with DS, stem from a problem with the procedural memory system suggested by the phonological deficit as hypotheses. Rather than a deficit in the procedural memory system itself, other underlying factors may be responsible (Rondal, 2017). In order to extract a morphosyntactic rule (like the RSPT) over time, the child must hear and retain the syntactic frame (including the morphosyntax) to identify these morphosyntactic patterns/rules. Given the difficulties with hearing and phonological short-term memory associated with DS, it is possible that these underlying factors are restricting the use of a relatively intact procedural memory system. This could explain why the intervention, that promoted ideal listening conditions and used visual cues, led to the children being able to implicitly apply and generalise the rule. This may also explain why children with DS have more difficulty with morphosyntax than other children with similar cognitive delays (non-DS) (Chapman, 2006).

This study is the first relatively large, randomised control trial for children with DS to target the use of a grammatical rule. The data shows that the children made significant gains in the use of the RSPT and that these gains generalised to untaught items following intervention. This evidence supports the effectiveness of an intervention that uses implicit and explicit strategies linked to the speech, language and cognitive profile associated with DS. It also demonstrates the feasibility of training TAs to deliver intervention targeting morphosyntax. This evidence supports future interventions that use implicit and explicit strategies, linked to the profile associated with DS, to improve the specific language difficulties experienced by individuals with DS.

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Appendices

A. Information sheets and accompanying consent forms for Headteachers, parents, TA, child

Information sheet for Headteachers:

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



Address of school

Date

Dear Head teacher,

Project: Evaluating a language intervention for children with Down syndrome

This study has been approved by UCL Research Ethics Committee Project ID No: PENDING

My name is Rebecca Baxter and I am a speech and language therapist who specialises in children with Down syndrome. I am currently conducting a research project for my PhD at UCL into the expressive language skills of children with Down syndrome as this is reported to be a specific area of difficulty for this population. The research involves evaluating a 10 week language intervention specifically targeting the use of past tense. The intervention is carried out in school by teaching assistants in daily 20 min sessions. The teaching assistants will receive 1 day training on the intervention, an intervention manual as well as fortnightly visits from myself and ongoing email/phone support. I am hoping that you will consider if you have any pupils who may be appropriate to take part in the study and if so, allow me to conduct the research on your school property. In addition I would require the identification of a teaching assistant to be recruited to carry out the daily intervention session and who would be able to attend a 1 day training workshop (alternatively more than 1 person can be identified to take on this role).

Details of the project: Evaluating a language intervention for children with Down syndrome.

Background: Many children with Down syndrome have specific difficulties with expressive language – being able to put sentences together and use grammar accurately. One of the areas reported to be of a specific difficulty for children with Down syndrome is the use of regular past tense for example jumped, splashed, brushed. Children with Down syndrome are reported to have visual learning strengths with the suggestion that learning from looking has benefits when teaching children with Down syndrome.

This project aims to evaluate whether a language intervention targeting the use of the regular past tense using visual strategies can be effective. The intervention is delivered by trained teaching assistants in daily 20 minute sessions over 10 weeks.

Method: Eighty participants aged 7-11 years will be recruited across Hampshire and the surrounding borders over a two year period. Participants will be randomly allocated to the intervention group or the waiting control group. Children will be assessed on a selection of standardised and bespoke measures at 3 time points to evaluate the effects of the intervention: 1) before the intervention; 2) after 10 weeks when the intervention group have received the intervention; and 3) after 20 weeks when the waiting control group have received the intervention.

Benefits for participants: Children taking part will have practice in understanding and using regular past tense in a range of activities including storytelling, retelling personal events, picture description. They will experience how to use past tense when talking about themselves and others. In addition they will have practice writing, learning letter sounds and word reading. All of the skills practiced in the intervention are important skills for language, communicating, friendships and literacy.

Data Protection: All data will be collected and stored in accordance with the Data Protection Act 1998. Each participant will be allocated a number. Only the number will be used on forms that include the age of the child

and the test results. A list of numbers and participant names will be kept separately in a locked drawer in a locked office in case any parent wishes their child's data to be withdrawn.

Who am I looking for?

I am looking for 7-11 year old child participants who have Down syndrome, are combining 2 or more words in their spoken language and have English as their first language. I am hoping to recruit 80 participants in total, 40 who will receive the intervention in the coming academic year 2016-2017 and a further 40 who will receive the intervention the following academic year 2017-2018. I am hoping to recruit participants across Hampshire and the surrounding borders. The parents of potential candidates will be sent an information sheet and consent form to complete if they wish their child to take part in the study. In addition, teaching assistants who are identified as potential participants will be sent an information sheet and consent form to complete if they wish to take part.

Child friendly information sheets will be given to the child and explained verbally if schools and parents agree to participate.

Each child that takes part will attend an initial assessment session to be carried out towards the end of the Autumn term. These assessments will be carried out by the researcher who is experienced with working with children with Down syndrome. This assessment session consists of a number of standardised and non-standardised assessments which are anticipated to involve 2 half days of testing. The total assessment time is approximately 1.5-2 hours however this will be broken up with rest breaks and can be completed over more days if necessary. The teaching assistant is welcome to sit in on these assessment sessions if they wish. The first 40 children will then be randomly assigned to one of two groups 1) the intervention group or 2) the waiting control group.

- 1) The intervention Group the consenting teaching assistant will attend a training day at the beginning of January. The 10 week intervention will then start on 16th January 2017 and end on 31st March 2017. For this 10 week period (5 weeks either side of half term) a daily 20 min session will be carried out by the teaching assistant and the researcher/speech and language therapist will visit on a fortnightly basis. These joint sessions will be video recorded and the sessions will be analysed at a later date. The teaching assistant will be asked to maintain a diary of the sessions administered. At the end of the intervention the children and teaching assistant will cease the 20 min intervention sessions and return to everyday school activities.
- 2) The waiting control group will continue with their everyday school activities as normal for the Spring term. The identified teaching assistant will attend a training day at the end of April. The 10 week intervention will then start on 2nd May 2017 and end on 14th July 2017. For this 10 week period (4 weeks before half term and 6 weeks following) a daily 20 min session will be carried out by the teaching assistant and the researcher/speech and language therapist will visit on a fortnightly basis. These joint sessions will be video recorded and the sessions will be analysed at a later date. The teaching assistant will be asked to maintain a diary of the sessions administered. At the end of the intervention the children and teaching assistant will cease the 20 min intervention sessions and return to everyday school activities.

All children will be assessed using a smaller number of specific language tests at the end of the Spring term and again at the end of the Summer term.

It is necessary that a relatively quiet space is identified for the assessments and the daily sessions e.g. a separate room, space in the library, a classroom or corridor. In total the researcher will visit your school for the assessment sessions and for 5 visits to observe sessions, discuss strategies and support school staff and provide adaptations where necessary. These times will be arranged to be convenient for school.

All assessment sessions and daily intervention sessions will occur at the child's school. The researcher will bring all of her own equipment. These sessions will be video recorded for later analysis and the videos will be

destroyed at the end of the project. This analysis will include the child's performance on the assessments and activities, their learning style and behaviour as well as the consistency of the sessions delivered. These videos will then be destroyed at the end of the project.

All data collected will be anonymised and managed in accordance with the Data Protection Act, ensuring that the children, the school and the staff cannot be identified. The child will be allocated a participant number. All information collected on the child and their teaching assistant will be associated with this number. Your name and school name will NOT appear on any test forms or reports on the project. We will keep a separate list of names and participant numbers in case any schools or parents want us to withdraw their data.

If you agree to assist me with this project, please could you complete the attached consent form and return it to me. You can post this to me at my address below and/or attach it to an email to me

I will then send you further details as well as the information sheets and consent forms for you to pass on to the appropriate parents and teaching assistants.

I am very happy to discuss this further with you, so please do not hesitate to email me or call me using the contact details below. If you would prefer I could visit you at school for a discussion.

I look forward to hearing from you

Best wishes

Consent form for Headteachers:

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



Title of project: Evaluating a language intervention for children with Down syndrome

This study has been approved by the UCL Research Ethics Committee Project ID Number: [pending]

Name, Address and Contact Details of Investigators:
Principal Researcher: Rebeca Baxter, PhD student at University College London, Speech and Language

Principal Researcher: Rebeca baxter, PhD student at University College London, Speech and L Therapist Principal Supervisor: Professor Charles Hulme, Chair of Psychology, University College London Language and Cognition Research Department, University College London, Chandler House, 2 Wakefield Street, London WC1N 1PF

Thank you for taking the time to consider allowing your school to take part in this research. Before you agree to take part, the person organising the research must explain the project to you. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide. You will be given a copy of this Consent Form to keep and refer to at any time.

Participant's Statement of Head teacher of participant's school

I	, nead teacher of		
•	have read the notes written above and the Information Sheet, and understand what the study involves.	lease [tick]
•	understand that if I decide at any time that I no longer wish the school to take part in this project, I can notify the researchers involved and withdraw immediately.	[]
•	consent to the processing of students' personal information for the purposes of this research study. $ \\$	[]
•	understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.	[]
•	agree that the research project named above has been explained to me to my satisfaction and I agree to take part in this study.]
•	agree that students' data, after it has been fully anonymised, can be shared with others	[]
•	agree to allow the researcher to recruit children from my school	[]
•	give permission for assessment sessions and intervention sessions be video-recorded during t project. I understand these videos will destroyed at the end of the project]
•	give permission for assessment sessions and intervention sessions be video-recorded during t project. I understand these videos will destroyed at the end of the project]
•	agree to relevant staff attending a one day training on the intervention]]
•	agree to relevant staff delivering a daily 20 min intervention session within the school day	[]
•	agree to the researcher carrying out assessments on school premises	[]
•	agree to the researcher visiting the school on a fortnightly basis for the 10 week intervention block	[]
•	agree to provide a suitable environment for the assessments and the intervention to be carried out $ \\$	[]
Signed:			
Date:			
Numbe	r of children in school who require information and consent forms for parents		
Please	return this form to: Rebecca Baxter,		

Information sheet for parents:

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



Address of school

Date

Dear Parent/Caregiver

Project: Evaluating a language intervention for children with Down syndrome.

This study has been approved by UCL Research Ethics Committee Project ID No: 6602/001 [PENDING]

Name, Address and Contact Details of Investigators:

Principal Researcher: Rebeca Baxter, PhD student at University College London, Speech and Language Therapist

Principal Supervisor: Professor Charles Hulme, Chair of Psychology, University College London Language and Cognition Research Department, University College London, Chandler House, 2 Wakefield Street,

London WC1N 1PF

My name is Rebecca Baxter and I am a speech and language therapist who specialises in children with Down syndrome

I am currently conducting some research for my PhD at UCL into the expressive language skills of children with Down syndrome. We would like to invite your child to participate in this research project. The project will begin recruitment on, if you wish your child to take part in this study, please complete and sign the attached consent and return it to consent form. Choosing for your child not to take part will not disadvantage you or your child in any way. Before you decide whether you want your child to take part, it is important for you to read the following information carefully and discuss it with others if you wish. You could discuss this with your child's teacher, SENCo, or contact the principal researcher directly (contact details above). Please ask if there is anything that is not clear or if you would like more information.

What is the purpose of the project?

Many children with Down syndrome have specific difficulties with expressive language – being able to put sentences together and use grammar accurately. One of the areas reported to be of a specific difficulty for children with Down syndrome is the use of regular past tense for example jumped, splashed, brushed. Children with Down syndrome are reported to have visual learning strengths with the suggestion that learning from looking has benefits when teaching children with Down syndrome.

This project aims to evaluate whether a language intervention targeting the use of the regular past tense using visual strategies can be effective. The intervention is delivered in school by trained teaching assistants in daily 20 minute sessions over 10 weeks.

Why has your child been chosen to take part?

S/He has been chosen because s/he is between 7-11 years of age, has Down syndrome, is combining 2 or more words in their spoken language and have English as their first language. Your school has identified your child as a possible participant and are willing to take part in the project.

Who will give consent for a child to take part?

We ask the Head teacher of your school to provide consent to recruit and allow their staff to take part in the study. We ask parents to give consent for their child to take part in the study (see form attached).

Does my child have to take part?

If you would like your child to take part please complete and sign the consent form attached to this document. If you would prefer your child NOT TO take part in the study there is no form to sign. If in the future you decide you do not want your child to continue to participate, you are free to withdraw your child at any time.

What will happen if my child takes part in the project?

Your child will attend an initial assessment session to be carried out towards the end of the Autumn term. The assessments involve looking at a range of pictures, words and letter sounds. Your child will be asked to point to corresponding pictures/words/sounds and name and describe some pictures. The total assessment time is approximately 1.5-2 hours but this will be carried out over 2 half days with breaks. This will be organised at a time that is convenient for your child and the teaching staff. Before they start your child will be given a simplified version of this information, which will be explained and discussed with them. The assessments will be carried out by the researcher who has experience of working with children with Down syndrome.

All the assessment sessions and some of the intervention session will be video recorded for later analysis. These videos will then be destroyed at the end of the project.

You will be asked to complete a Family Questionnaire about your child's general development and home environment. This will help us gain an overall picture of your child, their abilities and their progress. If you would like help completing this questionnaire please contact us and the researcher will arrange to talk through complete this with you.

After the assessments, your child will be randomly assigned to one of two groups 1) the intervention group or 2) the waiting control group.

- 1) The intervention Group an identified teaching assistant will attend a training day at the beginning of January. The 10 week intervention will then start on 16th January 2017 and end on 31st March 2017. For this 10 week period (5 weeks either side of half term) a daily 20 min session will be carried out by the teaching assistant and the researcher/speech and language therapist will visit on a fortnightly basis. When not doing the 20 min intervention session the children will continue with school and any other therapy as usual. At the end of the intervention the children will cease the 20 min intervention sessions and return to everyday school activities throughout the day.
- 2) The waiting control group will continue with their everyday school activities as normal for the Spring term. The identified teaching assistant/member of school staff will attend a training day at the end of April. The 10 week intervention will then start on 2nd May 2017 and end on 14th July 2017. For this 10 week period (4 weeks before half term and 6 weeks following) a daily 20 min session will be carried out by the teaching assistant and the researcher/speech and language therapist will visit on a fortnightly basis. When not doing the 20 min intervention session the children will continue with school and any other therapy as usual.

All children will be assessed using a smaller number of specific language tests at the end of the Spring term and again at the end of the Summer term.

All data will be collected and stored in accordance with the Data Protection Act 1998.

Your child will be allocated a participant number. All information collected on your child will be associated with this number. Your child's name and school name will NOT appear on any test forms or reports on the project. We will keep a separate list of names and participant numbers in case any parents and children want us to withdraw their data.

It is up to you and your child to decide whether you want to take part.

If you would like to take part, please complete and sign the attached consent form and return it to us. If you do not return the attached consent form we will assume that you do not want your child to participate. Even if your child takes part in the study, you can still ask us to withdraw their data from our project at any time and without giving a reason.

If you choose not to participate, you won't incur any penalties or lose any benefits to which you might have been entitled.

Will my child be at risk if s/he takes part in the study?

No. The teaching assistant who will be carrying out the daily intervention is a teaching assistant from your child's school. The testing and intervention will take place at your child's school. The researcher/speech and language therapist visiting school and carrying out assessments has an enhanced DBS check and many years of experience of working with children who have Down syndrome. Motivating rewards and adaptations are included in the intervention to prevent your child from becoming bored and the intervention has been designed to meet the learning needs of children with Down syndrome.

Will my child benefit from taking part in this project?

Children taking part will have practice in understanding and using regular past tense in a range of activities including storytelling, retelling personal events, picture description. They will experience how to use past tense when talking about themselves and others. In addition they will have practice writing, learning letter sounds and word reading. All of the skills practiced in the intervention are important skills for language, communicating, friendships and literacy.

Thank you for reading this information sheet and for considering to take part in this research.

Consent form for parents:

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



Project Title: Evaluating a language intervention for children with Down syndrome

This study has been approved by the UCL Research Ethics Committee Project ID Number: [pending]

Name, Address and Contact Details of Investigators:
Principal Researcher: Rebeca Baxter, PhD student at University College London, Speech and Language

Inerapist
Principal Supervisor: Professor Charles Hulme, Chair of Psychology, University College London
Language and Cognition Research Department, University College London,
Chandler House, 2 Wakefield Street,
London WC1N 1PF

Please return this form to: Rebecca Baxter,

Thank you for taking the time to consider allowing your child to take part in this research. Before you agree to take part, the person organising the research must explain the project to you. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you to decide. You will be given a copy of this Consent Form to keep and refer to at any time.

Child's Name		
School Name		
Participant's Statement of Parent of Participant		
l, parent of	Please	tick
 have read the notes written above and the Information Sheet, and understand what the study involves. 	[
 understand that if I decide at any time that I no longer wish my child to take part in this project, I can notify the researchers involved and withdraw him/her immediately. 	[]
 consent to the processing of my child's personal information for the purposes of this research study. 	h []
 understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998. 	[]
 agree that the research project named above has been explained to me to my satisfaction an I agree to take part in this study. 	nd [1
 agree that my child's data, after it has been fully anonymised, can be shared with other researchers 	[]
• give permission for assessment sessions and intervention sessions be video-recorded during this project. I understand these videos will destroyed at the end of the project	[]
 agree to complete the family questionnaire, I understand I can ask for help and complete this verbally with the researcher if I choose. 	[]
Signed:		
Date:		

Information sheet for teaching assistants:

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



Address of school

Date

Dear Teaching Assistant/Learning Support Assistant/Special Needs Assistant,

Project: Evaluating a language intervention for children with Down syndrome.

This study has been approved by UCL Research Ethics Committee Project ID No: PENDING

Name, Address and Contact Details of Investigators:

Principal Researcher: Rebeca Baxter, PhD student at University College London, Speech and Language Therapist

Principal Supervisor: Professor Charles Hulme, Chair of Psychology, University College London Language and Cognition Research Department, University College London, Chandler House, 2 Wakefield Street,

London WC1N 1PF

Project: Evaluating a language intervention for children with Down syndrome

This study has been approved by UCL Research Ethics Committee Project ID No: PENDING

My name is Rebecca Baxter and I am a speech and language therapist who specialises in children with Down syndrome I am currently conducting some research for my PhD at UCL into the expressive language skills of children with Down syndrome. The Head teacher of your school has identified a child who we are inviting to participate in this research project and has identified you as a possible member of school staff to deliver the intervention.

The project will begin recruitment on, if you wish to take part in this study, please complete and sign the attached consent and return it either to your Head teacher or to mysel postal address at the end of the consent form. Before you decide whether you want to take part, it is important for you to read the following information carefully and discuss it with your Head teacher. You could also discuss this with your child's teacher, SENCo, or contact the principal researcher directly (contact details above). Please ask if there is anything that is not clear or if you would like more information.

My name is Rebecca Baxter and I am a speech and language therapist who specialises in children with Down syndrome
I am currently conducting a research project for my PhD at UCL into the expressive language skills of children with Down syndrome as this is reported to be a specific area of difficulty for this population. The research involves evaluating a 10 week language intervention specifically targeting the use of past tense. The intervention is carried out in school by teaching assistants in daily 20 min sessions. The teaching assistants will receive 1 day training on the intervention, an intervention manual as well as fortnightly visits from myself and ongoing email/phone support. I am hoping that you will consider if you have any pupils who may be appropriate to take part in the study and if so, allow me to conduct the research on your school property. In addition I would require the identification of a teaching assistant to be

nominated to carry out the daily intervention session and who would be able to attend a 1 day training workshop (alternatively more than 1 person can be identified to take on this role).

What is the purpose of the project?

Many children with Down syndrome have specific difficulties with expressive language – being able to put sentences together and use grammar accurately. One of the areas reported to be of a specific difficulty for children with Down syndrome is the use of regular past tense for example jumped, splashed, brushed. Children with Down syndrome are reported to have visual learning strengths with the suggestion that learning from looking has benefits when teaching children with Down syndrome.

This project aims to evaluate whether a language intervention targeting the use of the regular past tense using visual strategies can be effective. The intervention is delivered in school by trained teaching assistants in daily 20 minute sessions over 10 weeks.

Why have you been chosen to take part?

The Head teacher of your school has identified one or more children in your school as a possible participant for this research project. The child has been chosen because s/he is between 7-11 years of age, has Down syndrome, is combining 2 or more words in their spoken language and have English as their first language. The Head teacher has also identified you as a suitable adult to deliver this intervention. If you agree to participate you will receive a day of training on the intervention, a manual containing activities and resources and support from a speech and language therapist who specialises in Down syndrome. This support will include a fortnightly visit to school and ongoing email/phone support from the speech and language therapist.

Who will to take part?

We ask the Head teacher of your school to provide consent to recruit children and staff to take part in the study. We ask school staff identified by the Head teacher to provide consent to take part (see attached form). We ask parents to give consent for their child to take part in the study.

Do I have to take part?

If you would like to take part please complete and sign the consent form attached to this document. If you would prefer NOT TO take part in the study there is no form to sign. If in the future you decide you do not want to continue to participate, you are free to withdraw your child at any time.

What will happen if I take part in the project?

The child will attend an initial assessment session to be carried out towards the end of the Autumn term. The assessments involve looking at a range of pictures, words and letter sounds. The child will be asked to point to corresponding pictures/words/sounds and name and describe some pictures. The total assessment time is approximately 1.5-2 hours but this will be carried out over 2 half days with breaks. This will be organised at a time that is convenient for the child and the teaching staff. The assessments will be carried out by the researcher who has experience of working with children with Down syndrome. You will be welcome to sit in on the assessment sessions if you wish.

After the assessments, the child will be randomly assigned to one of two groups 1) the intervention group or 2) the waiting control group.

1) The intervention Group – the identified teaching assistant will attend a training day at the beginning of January. The 10 week intervention will then start on 16th January 2017 and end on 31st March 2017. For this 10 week period (5 weeks either side of half term) a daily 20 min session will be carried out by the teaching assistant and the researcher/speech and language therapist will visit on a fortnightly basis. These joint sessions will be video recorded and the sessions will be analysed at a later date. The teaching assistant will be asked to maintain a diary of the sessions administered. When not doing the 20 min intervention session the teaching assistant will continue with their normal everyday school activities. At the end of the teaching assistant will cease the 20 min intervention sessions and return to everyday school activities throughout the day.

2) The waiting control group – the teaching assistant will continue with their everyday school activities as normal for the Spring term. The identified teaching assistant/member of school staff will attend a training day at the end of April. The 10 week intervention will then start on 2nd May 2017 and end on 14th July 2017. For this 10 week period (4 weeks before half term and 6 weeks following) a daily 20 min session will be carried out by the teaching assistant and the researcher/speech and language therapist will visit on a fortnightly basis. These joint sessions will be video recorded and the sessions will be analysed at a later date. The teaching assistant will be asked to maintain a diary of the sessions administered. When not doing the 20 min intervention session the teaching assistant will continue with their normal everyday school activities.

All children will be assessed using a smaller number of specific language tests at the end of the Spring term and again at the end of the Summer term.

All assessment sessions and daily intervention sessions will occur at the child's school. The researcher will bring all of her own equipment. These sessions will be video recorded for later analysis and the videos will be destroyed at the end of the project. This analysis will include the child's performance on the assessments and activities, their learning style and behaviour as well as the consistency of the sessions delivered. These videos will then be destroyed at the end of the project.

All data collected will be anonymised and managed in accordance with the Data Protection Act, ensuring that the children, the school and the staff cannot be identified. The child will be allocated a participant number. All information collected on the child and their teaching assistant will be associated with this number. Your name and school name will NOT appear on any test forms or reports on the project. We will keep a separate list of names and participant numbers in case any schools or parents want us to withdraw their data.

It is up to you to decide whether you want to take part.

If you would like to take part, please complete and sign the attached consent form and return it to us or your Head teacher. You can post this to me at my address below and/or attach it to an email to me

If you do not return the attached consent form we will assume that you do not want to participate. Even if you do take part in the study, you can still ask us to withdraw your data from our project at any time and without giving a reason.

If you choose not to participate, you won't incur any penalties or lose any benefits to which you might have been entitled.

I am very happy to discuss this further with you, so please do not hesitate to email me or call me using the contact details below. If you would prefer I could visit you at school for a discussion.

Thank you for reading this information sheet and for considering to take part in this research.

Best wishes

Consent form for teaching assistants

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



Title of project: Evaluating a language intervention for children with Down syndrome

This study has been approved by the UCL Research Ethics Committee Project ID Number: [pending]

Name, Address and Contact Details of Investigators:
Principal Researcher: Rebeca Baxter, PhD student at University College London, Speech and Language Therapist
Principal Supervisor: Professor Charles Hulme, Chair of Psychology, University College London
Language and Cognition Research Department, University College London,
Chandler House, 2 Wakefield Street,
London WC1N 1PF

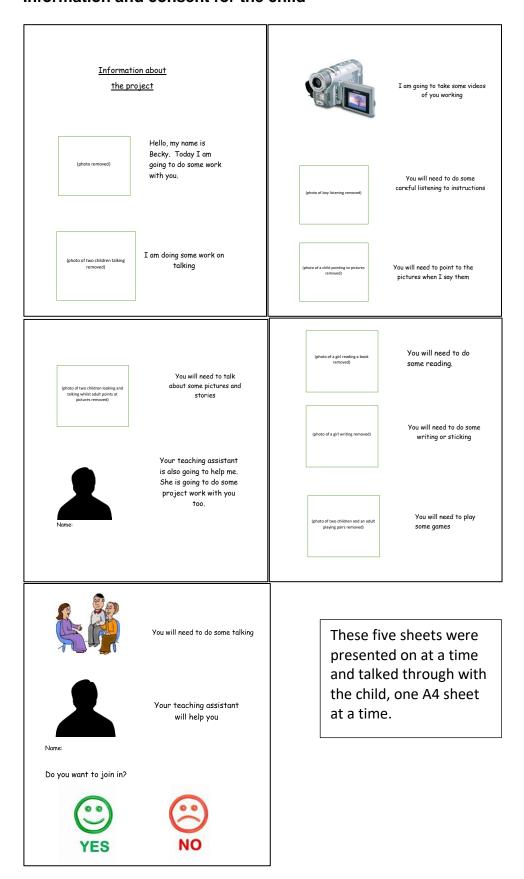
Thank you for taking the time to consider participating in this research. Before you agree to take part, the person organising the research must explain the project to you. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide. You will be given a copy of this Consent Form to keep and refer to at any time.

 $Participant's \ Statement \ of \ teaching \ assistant/learning \ support \ assistant/special \ needs \ assistant \ of \ participant's \ school$

	, teaching assistant/learning support assistant/special needs assist	ant at	
•	have read the notes written above and the Information Sheet, and understand what the	Please	tick
•	study involves.	[]
•	understand that if I decide at any time that I no longer wish to take part in this project, I can notify the researchers involved and withdraw immediately.]]
•	consent to the processing of session information for the purposes of this research study. $\label{eq:consent}$	[1
•	understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.	[]
•	agree that the research project named above has been explained to me to my satisfaction at lagree to take part in this study. $ \\$		1
•	agree that the data, after it has been fully anonymised, can be shared with others	[]
•	give permission for assessment sessions and intervention sessions be video-recorded during project. I understand these videos will destroyed at the end of the project	this []
•	agree to attend a one day training on the intervention]]
•	agree to deliver a daily 20 min intervention session within the school day	[]
•	agree to maintain a diary of the sessions delivered	[]
•	agree to the researcher visiting on a fortnightly basis for the 10 week intervention block	ſ]
•	agree to deliver the sessions in a suitable environment for the intervention to be carried out	[1
Signed:			
Date: .			

Please return this form to: Rebecca Baxter,

Information and consent for the child



B. Information sheets for speech and language therapists

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



INFORMATION SHEET FOR SPEECH AND LANGUAGE THERAPISTS

Project: Evaluating a language intervention for children with Down syndrome

This study has been approved by UCL Research Ethics Committee Project ID No: 6602/001

My name is Rebecca Baxter and I am a speech and language therapist who specialises in children with Down syndrome

I am currently conducting a research project for my PhD at UCL into the expressive language skills of children with Down syndrome as this is reported to be a specific area of difficulty for this population.

This information sheet is designed for any speech and language therapist working with a child whose family and school have signed up to participate in my research project.

The research involves evaluating a 10 week language intervention specifically targeting the use of past tense. The intervention is carried out in school by teaching assistants in daily 20 min sessions. The teaching assistants will receive 1 day training on the intervention, an intervention manual as well as fortnightly visits from myself and ongoing email/phone support.

The research project is a randomised control trial (RCT) and therefore the children have been randomly allocated to one of two groups: Group 1 The Intervention Group; Group 2 The Waiting Control Group. All children will receive the intervention, Group 1 will receive the intervention this spring term and Group 2 will receive the intervention in the summer term.

All children participating should continue to receive any speech and language input they usually receive either through the NHS, the Local Authority of through a private therapist. The RCT design of the project takes this into account.

Enclosed are the details of the project for your information as a speech and language therapist working with a child who is participating in the project. If you have any question or would like to discuss the project in more detail please do not hesitate to contact me.

Best wishes

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



Details of the project: Evaluating a language intervention for children with Down syndrome.

Background: Many children with Down syndrome have specific difficulties with expressive language — being able to put sentences together and use grammar accurately. One of the areas reported to be a specific difficulty for children with Down syndrome is the use of regular past tense for example jumped, splashed, brushed. Children with Down syndrome are reported to have visual learning strengths with the suggestion that learning from looking has benefits when teaching children with Down syndrome.

This project aims to evaluate whether a language intervention targeting the use of the regular past tense using visual strategies can be effective. The intervention is delivered by trained teaching assistants in daily 20 minute sessions over 10 weeks.

Method: Participants aged 7-11 years will be recruited across Hampshire and the surrounding borders over a two year period. Participants will be randomly allocated to the intervention group or the waiting control group. Children will be assessed on a selection of standardised and bespoke measures at 3 time points to evaluate the effects of the intervention: 1) before the intervention; 2) after 10 weeks when the intervention group have received the intervention; and 3) after 20 weeks when the waiting control group have received the intervention.

Benefits for participants: Children taking part will have practice in understanding and using regular past tense in a range of activities including storytelling, retelling personal events, picture description. They will experience how to use past tense when talking about themselves and others. In addition they will have practice writing, learning letter sounds and word reading. All of the skills practiced in the intervention are important skills for language, communicating, friendships and literacy.

Data Protection: All data will be collected and stored in accordance with the Data Protection Act 1998. Each participant will be allocated a number. Only the number will be used on forms that include the age of the child and the test results. A list of numbers and participant names will be kept separately in a locked drawer in a locked office in case any parent wishes their child's data to be withdrawn.

C. Family questionnaire

Research Department of Language and Communication UNIVERSITY COLLEGE LONDON



Language Intervention Project Family Questionnaire

CONFIDENTIAL

Family Ouestionnaire

The following questions concern your child's general development and the home environment and are important in helping us gain an overall picture of your child, their abilities and their progress. However, if you would prefer not to answer any questions then please leave the answer space blank. If you feel that any of the questions do not apply to you then please put N/A. If you would like help filling this questionnaire in or would like to talk though the questions with the researcher please let us know and we will be happy to arrange a suitable time.

Child's code (this ensures confidentiality)
elation to child of person giving the information
nte

Child Health & Development Questions

 What form of Down syndrome does your child have? (glease circle) 	Trisomy 21 Translocation Mosaic Don't know
2. Does your child have an additional diagnoses?	Autism Spectrum Disorder ADHD OCD Other (please describe)
If yes, at what are was your child diagnosed?	wrs mthe

2. At what are did your shild any his /how first wands?	makba
3. At what age did your child say his/her first words?	yrs mths
3. Has your child ever received any of the following; portage, occupational therapy, physiotherapy?	Yes / no
If yes, please describe (e.g. when, how long for)	
i j yes, piease describe (e.g. when, now long jor)	
4. Is English the only language spoken at home?	Yes / no
If no, please give details	
5. Is your child's health good at present?	Yes / no
If no, please describe	
6. Does s/he take any regular medication?	Yes / no
If yes, please name the drug and the condition for which it is taken	-
, , ,	
7. Has your child had any serious injuries or accidents, e.g. head injuries,	Yes / no
broken bones?	, -
If yes, please describe	
77-7F	
8. Has your child's vision been tested?	Yes / no

If yes, was it within			/ no
RIGHT EYE	Tick where applicable	LEFT EYE	Tick where applicable
Long-sighted		Long-sighted	
Short-sighted		Short-sighted	
Astigmatism		Astigmatism	
Accommodation (focussing)		Accommodation (focussing)	
Squint		Squint	
Don't know		Don't know	
Other (please specify)		Other (please specify)	
	ar glasses? hearing been tested?		Yes / no Yes / no
If yes, when?	-		
	normal limits?		Yes / no
was your crim	d diagnosed with a hearing i	трантенся	Yes / no
If your child has bee	en diagnosed with a hearing	impairment, please fill i	in the following tables
RIGHT EAR	Tick where applicable	LEFT EAR	Tick where applicable
Mild loss		Mild loss	
Moderate loss		Moderate loss	
Severe loss		Severe loss	
Don't know		Don't know	
Other (please specify)		Other (please specify)	
10. Has your child l	had repeated bouts of ear inf	ections (otitis media)?	Yes / no
ij yes, now regular:			
11. Has your child l	•		Yes / no
12. Is your child lef	t or right handed?		R L

Family Background Questions

13. Who is your child living with at the moment?	
14. How many children are there in the family?	
15. How many of the children live at home?	

16. What is the position of your child in family? (please circle)	First born Second born 3-4 More than 4 th
	Note if there are multiple births
17. What are your current occupations?	MUM
	DAD
18. If you are currently not working, what was your previous occupation?	MUM
	DAD
19. If applicable: What is step-parent's / new partners occupation?	
20. What ages did you complete <u>full time</u> education?	MUM
	DAD
21. What is the highest level of formal qualifications you have achieved (e.g., GCSE's, GNVQ, NVQ, A levels, Degree, Diploma)?	MUM
	DAD

Speech and Language Questions

22. Is your child currently receiving speech and language therapy?	Yes/No
If no, please give month and year of last appointment	ent and reason for discharge
23. If your child is currently receiving speech and language therapy what was the date of their last session with a speech and language therapist	DD/MM/YYYY

	24. If your child is currently receiving speech and	NHS	
	language therapy is this through the NHS or a	Private	
	private therapist	Both	
		N/A	
	25. If your child is currently receiving speech and	NHS:	
	language therapy how often do they see a speech	weekly/fortnightly/half	
	and language therapist	termly/termly/yearly/other	
		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
		Private:	
		weekly/fortnightly/half	
		termly/termly/yearly/other	
		N/A	
	28. If your child is currently seeing a speech and lar your child is working on: (or alternatively attach a or	nguage therapist can you please detail the targets	
14/			
		to advise them of the intervention. We will advise that	
		d to request that they continue as usual while your chil	id is
in the in	tervention. If you are happy for us to do this please c	omplete the following details:	
_			
Name of	speech and language therapist:		
Contact	address:		
Contact	audress.		
Contact	email:		
Contact	telephone number:		
Is there	ANY OTHER INFORMATION YOU WOULD LIKE TO ADD	that you think may we find relevant about your child?	

Family contact details:	
Current address	
Current telephone number	
Current email address (if applicable)	
Preferred method of contact	
□Letter	
☐Phone call	
□Email	
How did you find out about the project?	
	_
□Direct contact	
☐Word of mouth	
☐From school	
Other. Please state	
Many thanks for filling this questionnaire in!	

Please return this questionnaire to: Rebecca Baxter,

D. Bespoke RSPTP taught and untaught assessment instructions

Bespoke Regular Simple Past Tense Probe (Taught and untaught) Materials: Video recorder 60 picture pairs for picture description (40 verbs used in training and 20 matched verbs only used in assessment) presented on an iPad. Record sheets Instructions:

(photo of boy posting a letter through a door removed)	(photo of same boy having posted the letter through the same door removed)
--	---

Show the child the first pair of pictures – practice 1: posting

Say, "I have two pictures. I will describe the first one and you tell me about the second one. Let's try one." (Point to the picture for 'chopping') "Here the girl is chopping. (Point to the completed picture.) Now the girl is finished. Tell me what the girl did." Present each item to the child using the standard prompt above.

Prompting:

For each item, if the child's response:

does not include a verb, use the alternate prompt: Say, "Here the boy/girl is ______. Now the boy/girl is finished. Tell me what the boy/girl did. The boy/girl . . ." Provide this alternate prompt only once for each item. Wait for the child to complete the response, then record the response. If the child still does not provide a verb then use the final prompt.
 is ambiguous or includes a generic past tense structure, such as, "She's done" or produces a generic repetitive phrase such as "She finished," or an irregular form, say, "Yes, she's done (or she finished), but tell me what the girl did in the picture, or use the same word I use." Repeat standard instruction. Provide this prompt only once per item. If the child still does not provide the targeted form, administer the final prompt

Repeat with the second pair of pictures – practice 2: colouring

(photo of boy	(photo of same boy
colouring a picture of	holding up the
a pirate removed)	completed pirate
	picture removed)
	İ

Scoring:

Score 1 for the use of the regular simple past tense (used in complete or fragment response e.g., "chopped").

Score 0 for any other form (e.g., bare form, use of auxiliary, use of progressive -ing)

Example items

Splashing:

(photo of boy splashing in a water tray removed)	(photo of same boy soaking wet next to the same water tray removed)
	removed)

Stopping:

(photo of school patrol crossing officer holding out stopping sign removed)	(photo of same boy soaking wet next to the same water tray removed)

Counting:

(photo of girl pointing her finger along a row of toy cakes laid out on a number line to 1-5)	(photo of same girl holding up numeral 5 with one hand and 5 fingers of the other)

E. Narrative retell instructions

Materials:

☐ Video recorder ☐ 4 picture story

Narrative Retell Task

Ц	Story and comment sheet				
Instruct	ions:				
2.	Explain to the child you are going to tell them a story and that they should listen carefully as when you have finished you will ask them to retell the story to the puppet. Tell the story and point to the relevant parts of the corresponding pictures as you talk. When you have finished tell the child it's their turn to tell the story and turn the pictures back to the start for them. If the child has difficulty, prompt them with general questions such as "What happened here? What happened next? And then?" Do not give any further information or retell any				
	parts of the story. Ensure you give eye contact and encouragement for their attempts at telling the story.				
Story 1:					
Picture the ga	e 1 – It was a sunny day. The boy played with the dog in the garden. The postman opened te.				
comm	comments/nonverbal behaviour:				
	e 2 – While the postman posted the letters he said good morning to the boy. Suddenly g jumped over the step and ran off up the road.				
comm	ents/nonverbal behaviour:				
	e 3 – The dog ran all the way to the park. At the park he rolled in the mud and got very The boy was very cross. The boy carried the dog all the way home.				
comm	ents/nonverbal behaviour:				
	e 4 – When he got home he washed the dog. The dog was very happy. The dog licked the he boy laughed.				
comm	ents/nonverbal behaviour:				

Scoring:

To be transcribed from video. Record all child's utterances.

Story transcriptions should be scored for

- total number of words (TNW),
- number of different words (NDW)
 mean length of utterance (MLU)
- 4. Number of regular past tense forms used (PT)

F. Teaching assistant training



The intervention project

• To evaluate an language intervention for children with Down syndrome

- Regular past tense

- Use of print

- Modelling and imitation/evoked production

• Bigger questions

- Can children with Down syndrome be taught to understand and apply a grammatical rule?

- Any evidence for the effectiveness of speech and language therapy?

1

Project design

Based on a speech and language (SLT) model
10 week intervention
School based intervention
Delivered by trained teaching assistants
Daily 20 min 1:1 sessions
SLT support and training – fortnightly visit

Intervention

Monday

Introduce 4

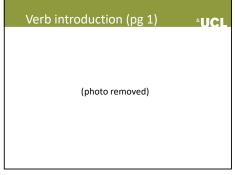
New iew

Nex iew

New
Past tense

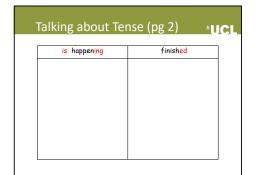
The tricky English language!
Regular past tense
Root verb
The ___ is xxxing vs The ___ xxxed
Different sounding ends*
(Irregular past tense)
Time words

Monday
Introduce the word web*
Introduce vocabulary 'verbs'
Introduce the word web*
Introduce the word we



Talking about Tense (pg 2)
Sequencing board*
Action picture cards* "finished"
Introduce the concept of "is happening" vs. "finished"

— "the ___ is xxxing" vs. "the ___ xxxed"
Sorting using the words and the colour
Monday (but is included in later activities)



Story retell (pg 4)

• 4 picture story*

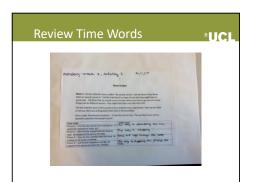
• Centres around the 4 verbs for the week

• Developing their event retell skills
Listening to the story

• Story script

• Record the child's spoken retell (no prompting)

10



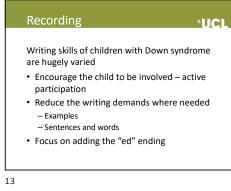
Story retell (pg 4)

Story retell

Detailed instructions to begin with
Include the 4 target words – past tense
First, next, then, last
Offer choices
Extend to the appropriate level
Rereading the story – daily withdrawing prompts

12

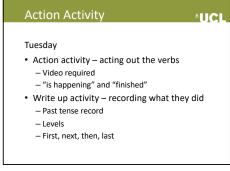
26/01/2023





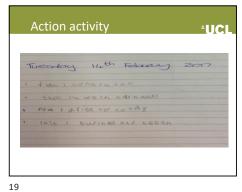


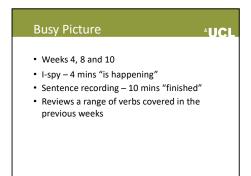
ucl • Many of the activities have 1-3 levels • Level 1 – focuses on the simple sentence structure and the "is" and verb endings • Level 2 – works at the child being more independent at the simple sentence level • Level 3 – works at the more complex sentence and text level These are a guide – adjust as needed, we will review this during the visits

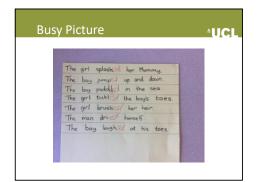


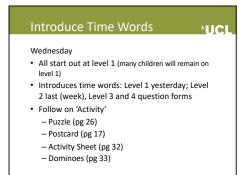


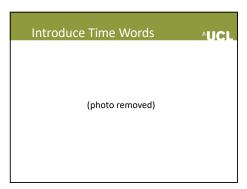
26/01/2023

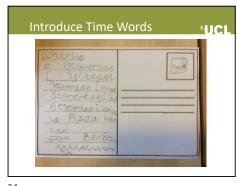




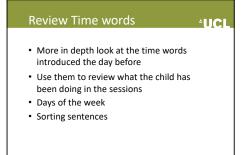




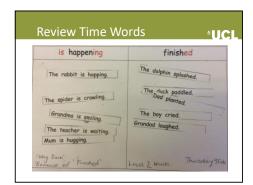








26



Verb Games UCL • Charades (pg 11) • Matching pairs (pg 12) • Barrier game (pg 18) • Sentence game (pg 19) • Memory game (pg 22) • Snap (pg 22)

27



Consolidation Session (pg 12) *UCL • Record book $- \, \mbox{An ongoing record}$ and a resource for activities - Record the date, day and week • Record sheet from Tuesday • Activity sheet from Wednesday • Choose favourite activities from any week so far (or you might like to take it in turns!)

Action Activity write up

'Rules' of the project

≜UCL

The intervention is designed to be delivered EVERY day and ALL of the activities should be covered

- Keep a record of all of the sessions tick off on the planner
- Timings stick to timings (no more/no less!)
- Missed sessions try and make them up
- Be honest

32

Final questions and comments **LUCL**

Irregular verbs

31

- Speech accuracy and sign/cued articulation
- ❖ Keep in touch 07712 400966 languageintervention@letsgouk.org
- Record books should go home to parents at the end of the intervention
- Assessments
- ❖Thank you!

Other comments/questions *UCL

- If you find your school not giving you the time
- SLT input
- Notebooks
- Behaviour

33

G. Newsletters

A language intervention for children with Down syndrome

Rebecca Baxter (PhD student, Division of Psychology and Language Sciences) Supervisors: Prof Charles Hulme, Dr Rachel Rees and Dr Alexandra Perovic



We have now reached half way in the language intervention for group A and I thought it would be good to give you an update about all that has been achieved.

As a reminder the language intervention is focussed on developing the use of the regular past tense. It has been specifically designed to meet the learning profile of children with Down syndrome. The intervention is delivered by trained teaching assistants to children on an individual basis and the children receive 20 minutes of input each day. Schools are supported by phone/email and are visited on a fortnightly basis.

The visits to school have also provided the opportunity to observe the intervention sessions and the positive developments in the children and TAs who are now more familiar with the programme and how to tailor it to their child.

I have been really impressed by the enthusiasm, commitment and skill of the TAs in the project and am ever-grateful for all their hard work.

What is the purpose of the study?

- Many children with Down syndrome have specific difficulties with expressive language -
- being able to put sentences together and use grammar accurately. One of the areas reported to be of specific difficulty for children with Down syndrome is the use of regular past tense for example jumped, splashed. This project aims to evaluate whether a language intervention targeting the use of the regular past tense using visual strategies can be effective.

How have the children been doing?

will be visiting all the children in the project throughout April to do full assessments of their expressive language skills. This will allow us to say with confidence whether or not the inte programme has been successful. All initial reports from TAs are certainly very positive.

The child used the past tense in the big write last week, I was really pleased. TA

His SLT commented that he is using 'is' much more in sentences. TA

You have to add 'ed' because it's finished – easy! Year 3 child

Some reminders:

- Parents if you have not returned your questionnaire please return it to
- Training for group 2 TAs will happen on either Friday 31st March 2017 in Wickham or Tuesday 25st April 2017 in Hartley Wintney. If you have not already booked onto one of the training days please let me know which datelvenue you will be attending.

 I will be contacting schools in the next couple of weeks to arrange dates to visit schools to assess all the children in April 2017.
- Here's a reminder of the timetable for the project:

(photo removed)

The boy is colouring

(photo removed)

The boy coloured

Pre-intervention assessments
Children are randomly allocated to the intervention group (A) or the waiting control group (B)

Group A receive 10 weeks intervention/Group B continue with regular class activities Post-intervention assessments 1 - for all children (April)

· Group B receive 10 weeks intervention/Group A return to regular class activities Post-intervention assessments 2 - for all children (July)

If you have any questions or wish to discuss the intervention please email Becky Baxter

A language intervention for children with Down syndrome

Rebecca Baxter (PhD student, Division of Psychology and Language Sciences) Supervisors: Prof Charles Hulme, Dr Rachel Rees and Dr Alexandra Perovic

The end of the school year is fast approaching and the end of the language intervention is in sight! Group B are just over half way through their 10 week block so I thought I would share how things have been going.

Group A finished their intervention block at the end of March and we were really pleased with the poisitve feedback from the schools. All of the children were then assessed on a variety of language measures in April which allowed us to compare the progress of Group A who had received the intervention to the progress of Group B who had been carrying on as ususal. We were very pleased with the early results.

Group B then started their intervention block at the beginning of May and have just competed week 6. Despite bank holidays, school trips and sports days the TAs have been ploughing on and I really appreciate their hard word and dedication to the project.

What have the children been doing?

- The children have been following a 10 week intervention which follows a similar weekly
- structure.

 Each week the children are introduced to 4 new verbs that they focus on for the week. The children then complete a range of activities using these 4 verbs including story reteil, acting out, role play, verb games and then recording the work they have completed. Each activity is designed to be adapted to the individual child and here are some examples of the fantastic work that has been going on.

What happens next?

Group B will complete the intervention over the next 4 weeks. All of the children will then be assessed on the language measures again in July to look at the progress of Group B and how Group A are scoring after a further 10 weeks.

At the end of the intervention the school will send home the manual for parents to read. The manual gives all the details of the programme, the activities and the resources. As part of the intervention the children have been keeping record books where they keep all of the work they have produced. These books will be collected at the assessment but will then be returned to the children later in the summer holidays.

To give more information about the intervention and to talk through the project we are going to hold an immoring in the summer holidays. Full details of the date and venue will be circulated in the next week sand eye out for the email and please respond if you are able to come along.

That will then be the end of the language intervention project for you but just the beginning for me as we plan to run the whole thing again next year with another group of children. If you know any families or schools who hav children with Down syndrome and will be in Years 3-6 from September please pass on the information and ask them to get in touch. Thanks as always for all your support.

progress and to review the speech and language input the children receive. Many thanks



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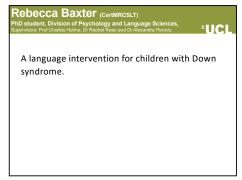




If you have any questions or wish to discuss the intervention please email Becky Baxter

H. Parent information session slides

25/01/2023



The intervention project

To evaluate an language intervention for children with Down syndrome

Regular past tense

Use of print

Modelling and imitation/evoked production

Bigger questions

Can children with Down syndrome be taught to understand and apply a grammatical rule?

Any evidence for the effectiveness of speech and language therapy?

Project design

Based on a speech and language (SLT) model

10 week intervention

School based intervention

Delivered by trained teaching assistants

Daily 20 min 1:1 sessions

SLT support and training – fortnightly visit

The tricky English language!

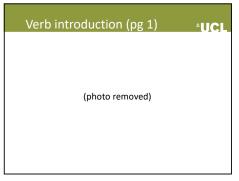
Regular past tense
Root verb
The ___ is xxxing vs The ___ xxxed
Different sounding ends*
(Irregular past tense)
Time words

Verb introduction (pg 1)

Monday

Introduce the word web*
Introduce vocabulary 'verbs'

4 new verbs each week
The action picture cards* - "is happening"
Page 7
Review verbs (Tues, Wed and Thurs)



Talking about Tense (pg 2)

• Sequencing board*

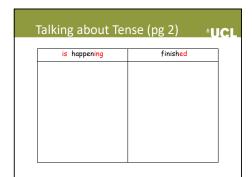
• Action picture cards* "finished"

• Introduce the concept of "is happening" vs. "finished"

— "the ___ is xxxing" vs. "the ___ xxxed"

• Sorting using the words and the colour

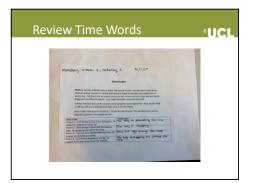
• Monday (but is included in later activities)



Story retell (pg 4)

4 picture story*
Centres around the 4 verbs for the week
Developing their event retell skills
Listening to the story
Story script
Record the child's spoken retell (no prompting)

10



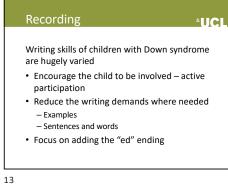
Story retell (pg 4)

Story retell

Detailed instructions to begin with
Include the 4 target words – past tense
First, next, then, last
Offer choices
Extend to the appropriate level
Rereading the story – daily withdrawing prompts

12

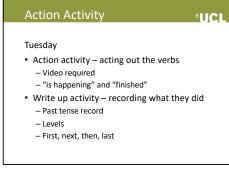
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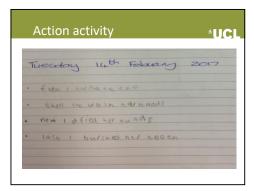


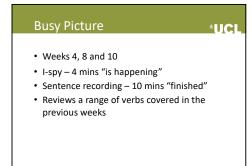


ucl • Many of the activities have levels • Level 1 – focuses on the simple sentence structure and the "is" and verb endings • Level 2 – works at the child being more independent at the simple sentence level • Level 3-4 – works at the more complex sentence and text level These are a guide – adjust as needed, we will review this during the visits

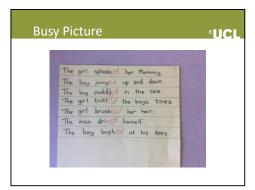








19 20



Introduce Time Words

Wednesday

All start out at level 1 (many children will remain on level 1)

Introduces time words: Level 1 yesterday; Level 2 last (week), Level 3 and 4 question forms

Follow on 'Activity'

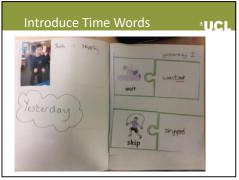
Puzzle (pg 26)

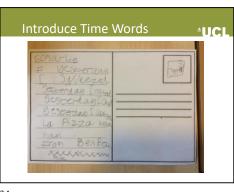
Postcard (pg 17)

Activity Sheet (pg 32)

Dominoes (pg 33)

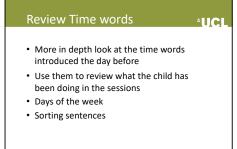
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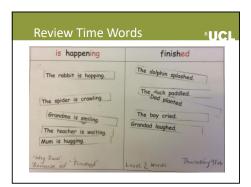


23 24





26

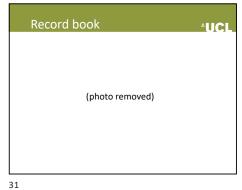


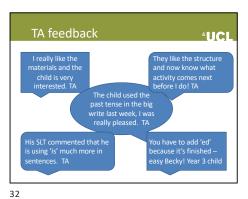
Verb Games UCL • Charades (pg 11) • Matching pairs (pg 12) • Barrier game (pg 18) • Sentence game (pg 19) • Memory game (pg 22) • Snap (pg 22)

27

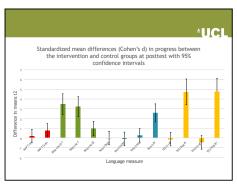


Consolidation Session (pg 12) *UCL • Record book – An ongoing record and a resource for activities - Record the date, day and week • Record sheet from Tuesday • Activity sheet from Wednesday • Choose favourite activities from any week so far (or you might like to take it in turns!)

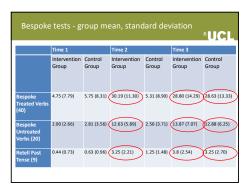


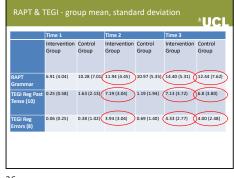


±UCL Time 1-Time 3 Bespoke Expressive tense marking test: 40 taught verbs and 20 untaught verbs
 The expressive test asks children to describe a second
 "finished" verb picture and a repetition task. Past Tense and Third Person Singular Probes from the Test of Early Grammatical Impairment (TEGI). Narrative language sample (expressive language): A bespoke test in which children are asked to retell a story using picture prompts Renfrew Action Picture Test (expressive information and grammar)



33





35

Support for generalisation •UCL

- Use the target phrases "is happening" vs "finished"
- Pick the children up they know this!
- Share the workbooks
- Redo the activities

37

• Extend to everyday diary/homework/classwork

Final questions and comments **LUCL**

❖ Irregular verbs – mini pack

38



? Do you know any other schools/families who would be interested in taking part?

I. Teaching assistant observation sheet

UCL		LETS Go!			
Observation Schedule: Language Intervention					
articipant:	TA:	Date:			
bserver: W	eek of intervention:	Day:			
erb introduction/review (3 mins)					
Observed: Y□ N□ Ac	tivity: Intro 🗆 Review 🗆	Length of section: mins			
Child finding correct pictures	Ý	ם א 🗅			
 Various strategies encouraged? 	The state of the s				
Evoked production	Y	ם א ם			
Comments:		1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -			
alking About Tense (3 mins)					
Observed: Y □ N □	Length of section:	mins			
Sequencing board introduced		Y D N D			
Pictures sorted		YOND			
 TA assistance appropriate? 		YOND			
Various strategies encouraged? (talk through matching and why)		y) Y 🗆 N 🗆			
Comments:	e services a many of				
stening to the Story (4 mins)					
Observed: Y□ N □	Length of section:	mins			
Story discussed, introduced and st	tory script used Y	ם א ב			
 Child's retell unaided 	Y	□ N □			
Appropriate recording of the story	Y	ם א ם			
 TA assistance appropriate? 	Y	O N O			
Comments:					
ory Retell (10 mins)					
Observed: Y □ N □	Length of section: mins				
 Verb input used 	Marco - Contraction of the	word cards/verb root □ written past tense on whiteboard □			
Child lead sentences?	Y 🗆 N 🗆	VENERAL TRUE 100 NO 15 N			
Linking of words and letters?	Y				

UCL	LETS Go!		
Appropriate amount of support?	Y O N O		
Appropriate level of recording?	Y 🗆 N 🗆		
Comments:			
ory review (3 mins)			
Observed: Y□ N□ Len	g: Y□N□ Length of section: mins		
 Concepts of print targeted (ed ending)? 	ÝΟΝΟ		
TA assistance appropriate (i.e. scaffolding?	Y 🗆 N 🗆		
3. W			
Comments:			
tion Activity – acting out (4 mins)			
Observed: Y □ N □	Length of section: mins		
Adult using target phrases	Y 🗆 N 🗅		
Child producing target phrases (inc. evoked)	d production) Y 🗆 N 🗖		
Video review appropriate	Y 🗆 N 🗀		
Comments:			
tion Activity (10 mins)			
Observed: Y □ N □	Length of section: mins		
Verb input used wor	word cards/verb root \square written past tense on whiteboard \square		
 Child lead sentences? 	YONO		
 Linking of words and letters? 	YONO		
 Appropriate amount of support? 	YONO		
 Appropriate level of recording? 	Y 🗆 N 🗀		
Comments:			
troduce Time Words (4 mins)			
Observed: Y □ N □	Length of section: mins		
Word introduced?	Y N Word used		
 Word used to review yesterday's work? 	YONO		

ÜCL	LETS Go!			
Comments:				
me Word Activity (10 mins)				
Observed: Y□ N □ Length of	section: mins			
Activity: Puzzle □ Postcard □ Sheet □	□ Dominoes □			
Verb input used we	ord cards/verb root ☐ written past tense on whiteboard ☐			
Child lead sentences?	d N O Y			
 Linking of words and letters? 	YO NO			
 Appropriate amount of support? 	YONO			
Appropriate level of recording?	YONO			
Comments:				
eview Time Words (4 mins)				
Observed: Y□ N□	Length of section: mins			
Word introduced?	Y □ N □ Word used			
Word used to review yesterday's work?	YONO			
Comments:				
imes (2 x 5 mins)				
Observed: Y□ N□ Length of	section: mins			
Activity: Charades/Pairs □ Barrier/Sent	tence Memory/Snap			
 Game played appropriately? 	Y 🗆 N 🗆			
 Evoked production used? 	YONO			
Comments:				
nsolidation session (3 mins)				
Observed: Y□ N□	Length of section: mins			
Concepts of print targeted (focussing on	ed endings)? Y D N D			
Tuesday and Thursday work reviewed	Y D N D			
2 activities repeated	YONO			
	g?) Y 🗆 N 🗅			

		LETS Go!
Comments:		
comments.		
GENERAL		
Organisation:	Grade: 1 🗆 2 🗆 3 🗆 4 🗅	
Tailoring to individual's needs:	Grade: 1 🗆 2 🗆 3 🗆 4 🗅	
Target strategies used:	Grade: 1 🗆 2 🗆 3 🗆 4 🗅 '	
Behavioural management:	Grade: 1 🗆 2 🗆 3 🗀 4 🗅	
Enjoyment:	Grade: 1 🗆 2 🗆 3 🗀 4 🗅	
Further comments:		
		- Termination - Termination