The impact of intervention *dose form* on oral language outcomes for children with Developmental Language Disorder

Pauline Frizelle, [1, 6] Anna-Kaisa Tolonen [2] Josie Tulip [3], Carol-Anne Murphy [4], David Saldana [5,] and Cristina McKean [3,]

[1] Pauline Frizelle (corresponding author), Department of Speech and Hearing Sciences, University College Cork, Republic of Ireland. Email: p.frizelle@ucc.ie

[2] Research Unit of Logopedics, Faculty of Humanities, University of Oulu, Finland

[3] Department of Speech and Language Sciences, School of Education, Communication & Language Sciences, Newcastle University, UK

[4] School of Allied Health, Faculty of Education and Health Sciences, University of Limerick, Republic of Ireland

[5] Departamento de Psicología Evolutiva y de la Educación, University of Seville, Spain

Conflict of Interest

The authors declare no conflicts of interest.

Funding Statement

This research paper was part of the work of the Cost Action IS1406 network entitled: *Enhancing children's oral language skills across Europe and beyond - a collaboration focusing on interventions for children with difficulties learning their first language.* The network was supported by COST (European Cooperation in Science and Technology) funded by the European Union [Grant: COST 106/14].This work was also

supported in part by an NHMRC fellowship to C.McK. (Centre of Research Excellence in Child Language 1023493).

RUNNING HEAD: Dose form manipulation in language interventions for DLD

Abstract

Purpose: To extract key learning from intervention studies in which qualitative aspects of dosage, *dose form,* have been examined for children with developmental language disorder (DLD) - in vocabulary, morphosyntax and phonology domains. This research paper emerged from a pair of systematic reviews, aiming to synthesise available evidence regarding qualitative and quantitative aspects of dosage respectively. Whilst quantitative aspects had been experimentally manipulated, the available evidence for *dose form* (tasks or activities within which teaching episodes are delivered) was less definitive. Despite this, the review uncovered insights of value to DLD research.

Method: A pre-registered systematic review (PROSPERO ID=CRD42017076663) adhering to PRISMA guidelines was completed. Included papers were: Quasi-experimental, RCT or cohort analytic studies, published in any language between January 2006 and May 2019; oral language interventions with vocabulary, morpho-syntax or phonology outcomes; and participants with DLD (M=3-18 years). The intention was to include papers in which dose form was experimentally manipulated or statistically analysed, while quantitative dosage aspects were controlled, such that definitive conclusions about optimal dose form could be drawn, and gaps in the evidence identified.

Results: 224 papers met the above inclusion criteria; 27 focused on *dose form*. No study controlled for all quantitative aspects of dosage such that we could effectively address our

original research questions. Despite this, key points of learning emerged with implications for future research

Conclusions: There is tentative evidence of advantages for explicit over implicit instruction, and of the benefits of variability in input, elicited production and gestural and other visual supports. With careful design of dose form, there is potential to design more efficient interventions. SLP research would benefit from an agreed taxonomy of dose form components and standardised reporting of intervention studies to enable cross-study comparisons and a systematic accrual of knowledge to identify optimal dose form for clinical application.

Introduction

Over the past 20 years, there has been an increased need for accountability in SLP practice both in educational and health settings. Increasingly, the focus of accountability is not only on effectiveness, but also efficiency of practice: an issue inextricably linked to intervention dosage. Warren et al. (2007) put forward five dosage characteristics to describe intervention intensity. Dose form is the qualitative dosage component of their taxonomy and refers to the tasks or activities within which the teaching episodes are delivered. It seems intuitive that differing dose forms will be more or less effective and therefore require more or less quantitative dosage to effect change. However, there is little guidance available for practice in this regard. This paper examines and synthesises current evidence regarding intervention dose form, with respect to children with Developmental Language Disorder (DLD), in the domains of vocabulary, morpho-syntax and phonology. We report findings from a systematic review which aimed to identify studies, which allow valid conclusions to be drawn regarding the *optimal and most efficient* dose forms used in interventions. That is, studies which compare the relative efficacy of differing dose forms, whilst controlling for quantitative aspects of dose. In the following we a) define and describe components of dose form in detail; b) describe the

range of dose forms used in interventions for children with DLD, reported in previous reviews (e.g. Cirrin & Gillam 2008; Marulis & Neuman, 2010; Proctor-Williams, 2009; Wren et al., 2018), and what is known about their effectiveness; and c) outline the aims and approach of the current study.

Defining dose form

Over time, the construct of dose form has been developed and refined. In 2009, Proctor-Williams built on the work of Warren and colleagues (2007) in her description of the components of dose form to include 'the commonly used techniques, procedures, and intervention contexts that constitute teaching episodes' (p. 295). In this new definition *techniques* are the specific actions/ teaching behaviors thought to have benefit and *procedures* refer to how these techniques are combined. *Intervention contexts* are described as falling on a continuum from highly child-centered, to hybrid, to clinician-directed (Fey, 1986).

We further specify and extend the *intervention contexts* component of dose form to capture potential other 'active ingredients', we judged as missing from the Proctor-Williams (2009) taxonomy: the *activity* in which the technique/ teaching behavior is being delivered and *the degree of variability* in the linguistic input, or materials used. We also add an additional component: the *method of instruction*, with specific reference to explicit versus implicit approaches. See Table 1.

Insert Table 1 about here

What do we know about techniques, procedures, methods of instruction and intervention contexts for children with DLD?

Techniques

Vocabulary. Techniques typically used in vocabulary interventions include exposing children to target words in varied contexts; using visual supports such as iconic gestures; development of meta-linguistic strategies during reading; use of stress/ slower speech rate; and

elaboration designed to give the child a richer knowledge of target words', semantics or phonology. A previous review by Cirrin & Gillam (2008), in relation to school aged children with oral language disorders, reported positive effects for slowed rate; interactional conversational reading strategies; and iconic gestures. However, few studies of vocabulary interventions have systematically compared the effectiveness of one technique relative to another. Additionally, prior to the Warren et al. (2007) paper, most studies did not fully report or consider the potential impact of quantitative aspects of dosage in the interpretation of their findings (Zeng et al., 2012).

Morphosyntax. Techniques most typically used in morphosyntax interventions are imitation; priming; modelling; recasting /enhanced conversational recasting; expansions; and elicitation prompting. While empirical studies show that these techniques facilitate morphosyntactic development in children with DLD (see Proctor-Williams, 2009), lack of information on quantitative dose again makes comparisons of techniques, problematic. There are substantial differences in how techniques, such as imitation training and modelling, are implemented (Eisenberg et al., 2020) and inconsistencies with respect to how these techniques are combined (e.g. Smith-Locke et al., 2015 (modelling recasting and cueing); Owen Van Horne et al. 2018 (drills, imitation, modelling and recasting)). Consequently, it is difficult to tease apart their relative effects. Contradictory findings regarding the relative impact of one technique over another are therefore not surprising. For example, with respect to a group of children with DLD, Courtright and Courtright (1979) found modelling resulted in higher target morpheme use than imitation, whereas Connell and Stone (1992) found imitation to be more effective than modelling.

Phonology. There is a wealth of different techniques in the field of phonological interventions, including the use of minimal and maximal sound contrasts, stimulability, meta-phonology, and auditory bombardment. However, few studies include children with DLD, and

focus instead on those with Speech Sound Disorders without DLD. In a recent review of published studies by Wren and colleagues (2018) 11 different 'procedures' were identified falling into five categories – environmental, auditory-perceptual, cognitive-linguistic, production or 'integrated' approaches. The authors conclude that it is currently not possible to determine which are most effective.

Method of Instruction – Explicit plus Implicit versus Implicit only

Interventions can also vary depending on whether they can be implemented explicitly, where the child is given information with respect to the rule underlying the teaching target, or implicitly, where they are required to induce the rule/ pattern (see Finestack (2018) for a detailed explanation of each).

Vocabulary. Explicit vocabulary interventions include providing detailed definitions and examples before, during, or after a book reading activity, with follow up discussions reviewing target vocabulary. An implicit approach on the other hand, would involve a story reading activity, including aspects such as slowed speech, emphasis of target words and gestures, without stopping to reflect on target word meanings or giving target word definitions. Techniques such as those that use analogical thinking/ verbal analogy (highlighting similarities between pairs of words), are thought to require explicit instruction, to be effective with children with language impairment (Masterson & Perrey, 1999). In contrast, results from a meta-analysis completed by Marulis and Neuman (2010) on young typically developing children and those 'at risk', suggest the highest effect sizes for interventions using a combination of methods of instruction.

Morphosyntax. With respect to morphosyntax, modelling, recasting and priming have been most frequently implemented implicitly (Camarata et al., 1994; Leonard et al., 2006), and have been criticized for achieving only moderate intervention effects (Finestack, 2018). For this reason, there has been a move towards using more explicit approaches such as the Shape

Coding system (Ebbels, 2014). However, although primarily an explicit approach, which visually codes grammatical rules to make them explicit to the child, the Shape Coding system can also be combined with techniques usually used implicitly, such as modelling, elicitation and recasting. Prior to those papers included in the review reported here, only one study in which quantitative dose was controlled, systematically compared an implicit and explicit intervention approach. The treatment target was a novel noun morpheme, and while overall response to treatment was low, generalization (among those that did respond) was greater in the implicit condition (Swisher et al., 1995).

Phonology. Explicit phonological interventions used with children with DLD include phonological awareness training, with positive effects reported, albeit in small scale quasi-experimental studies (Gillon, 2000), whilst implicit approaches such as phonological auditory 'bombardment', and minimal meaningful contrasts have not been tested, to our knowledge, in children with DLD, and often contain elements of explicit interventions alongside implicit approaches (Baker & McLeod, 2004; Hodson, 2015). Without systematically manipulating the methods of instruction within a given technique or intervention context, it is difficult to ascertain their respective impacts.

Intervention contexts

Lastly, techniques can be used in a range of intervention *contexts* that vary with respect to degree of structure and naturalness. In more recent years, therapy has moved from the use of highly structured/ decontextualized drills, to embedding targets in meaningful activities within a social context. Most recently, there has been increased interest in the impact of the *linguistic* context and, in particular, the variability of the input.

Vocabulary. Interactive book reading is an example of a meaningful activity in which targets can be embedded with respect to vocabulary. In relation to the linguistic context and variability of the input, most work has been conducted with typically developing children and

findings are mixed. Some has reported positive word learning effects using high referent variability with young typically developing children (Perry et al., 2010), other studies suggest that too much variability (across a number of features) can have a negative effect (Twomey et al., 2013). The impact of variability is also thought to be target dependant such that noun learning might be particularly enhanced by increased variability, but verb learning less so (Gómez, 2002; Maguire et al., 2008). Few studies have investigated the effect of variability in relation to word learning in children with DLD. Alt et al. (2014) found input variability to enhance vocabulary learning in a group of late talking toddlers.

Morphosyntax. Recasting is an example of a technique that can be embedded in a meaningful activity. Regarding the variability of the input, it is hypothesized that increasing input variability allows children to extract and generalize abstract grammatical rules more easily, informed in part by studies of artificial grammar learning. Work by Plante and colleagues (2014) is one example of the translation of this learning into a therapeutic context and is described later in this review. However, overall, surprisingly few studies have integrated increased variability into treatments for children with DLD.

Phonology: On the child-centred, clinician-directed continuum, phonological interventions tend to take a more clinician-directed approach. Categories of intervention put forward by Wren et al. (2018) also include an environmental approach, which encompasses phonological interventions that are embedded in everyday interactions, rather than directed activities, that focus solely on change in a child's speech-sound system. Again, the focus here is on those with speech sound disorder rather than DLD.

Current study

Systematic reviews of interventions for children with DLD have tended to focus on the overall effectiveness of different treatments and delivery models without looking specifically

199 at dose form (see Cirrin et al., 2010; Cirrin & Gillam, 2008; Law et al., 2004). Dose form has
200 been the point of discussion in two 'clinical forum' papers (Eisenberg, 2014; Kamhi, 2014)
201 and was reviewed by Proctor-Williams (2009) solely in the morphosyntax domain. Since then,
202 several informative papers, across domains, have been published. As a result of these
203 significant papers, bringing the importance of dosage to the attention of researchers and
204 clinicians, recently published intervention studies have begun to provide more detailed
205 information on the quantitative aspects of dosage. This development we believed, would allow
206 for a more valid assessment of the *relative efficacy* of different dose forms than had previously
207 been possible. Our aim was to capitalise on this opportunity and conduct a systematic review
208 and narrative synthesis of intervention studies for children with DLD in which aspects of oral
209 language intervention dose form were experimentally manipulated, or retrospectively
210 statistically analysed. The review was to be the second of a pair completed with similar
211 methodology: the first focussing on the quantitative aspects of dosage (see Frizelle et al., 2021).
212 However, the process was not straightforward in relation to dose form.
213 To allow for direct comparisons of different dose forms, we planned to include only
214 studies in which the efficacy of one intervention was compared to an alternative and studies in
215 which dose (number of teaching episodes per session), dose frequency and total intervention
216 duration were either controlled or reported in sufficient detail to allow valid conclusions
217 regarding the effects of dose form to be drawn. However, of those papers that did provide
218 information on the quantitative aspects of dose, there was significant variation in the levels of
219 detail reported, with some papers only providing information on planned dose and others giving
220 information on the discrepancy between what was planned versus what was received. It was
221 also problematic that some papers controlled for one quantitative aspect of dosage (such as
222 dose) but not another (such as dose frequency). As we progressed through the process, it
223 became increasingly evident that there were no papers that purely manipulated dose form

(while controlling for all quantitative aspects of dose) and therefore we could not definitively answer the research questions we planned to address.

However, although the quality of studies was such that it was difficult to draw definitive conclusions about the relative efficacy of varying dose forms, the process uncovered several key insights with the potential to be of value to the discipline of intervention research for children with DLD. Therefore, the aims of this research paper are to document and disseminate those insights. We present our learning from the papers reviewed under each of the subcategories of dose form described above. We then synthesise our findings and make recommendations regarding key next steps for the systematic accrual of knowledge, necessary in the field of DLD research, to identify optimal dose form for clinical application.

This paper is unique in that it systematically addresses the impact of dose form across domains, using the most up to date papers, which increasingly give information on quantitative dose, therefore bringing us closer to uncovering the unique contribution of dose form on intervention effectiveness for children with DLD.

Method

The review was registered with PROSPERO (ID=CRD42017076663) and our methods adhered to PRISMA guidelines for systematic reviews (Moher, 2009). The method is reported in more detail in our review of the quantitative aspects of dosage (Frizelle et al., 2021). More detailed definitions of our included research designs and our definition of intervention are given in the PROSPERO pre-registration (McKean et al., 2017) (ID=CRD42017076663).

Search Procedures

Searches were conducted to identify empirical peer reviewed articles, in any language, relating to oral language interventions with children with DLD, published January 2006 - May

2020. The study commenced in 2016 as part of a COST Action 1406 [1] and so the previous 10 years were targeted, to provide a comprehensive but manageable sample of papers to review. The review continued into 2020 and so the searches were updated to include a further 4 years. Seven electronic databases were used: Web of Science (Including Medline, SSCI), MEDLINE(PubMed), ERIC, PsycINFO, Cochrane Library, Scopus, and LLBA. (see Appendix A for search string). Reference lists of the final list of papers included and relevant systematic reviews were also hand searched for additional papers. Inclusion / Exclusion criteria are reported in supplementary material and in Frizelle et al. (2021) with one addition - Included papers experimentally manipulated or statistically analysed dose form whilst either a) keeping other quantitative variables such as dose constant or b) explicitly quantifying dose, dose frequency, total intervention duration and consequently cumulative intervention intensity, to a sufficient degree such that insights about the potential impact of dose form could be inferred. The review focused on interventions in which there were outcomes in the domains of vocabulary, morpho-syntax and phonology.

Paper Selection and Reliability of Search Procedures

Stage 1: The initial search formed the basis of several COST Action IS1406 reviews with differing foci. The aim was to identify papers evaluating interventions for children with DLD across all language domains. These papers were initially screened on title and abstract for inclusion/ exclusion based on the criteria of date, target group, level of evidence (whether there was an element of control included in the study design) or evaluation of an intervention. Twenty percent were double screened by two independent reviewers, using specialist software supporting systematic reviews (EPPI – Reviewer 4). Overall agreement was 96%. All non-English papers at this and subsequent stages were considered by either author AKT (who is

[1] Action 1406 focussed on understanding intervention and service delivery for children with DLD across Europe and a number of partner countries.

fluent in a number of languages) or by a native speaker of the relevant language in the COST Action and relevant criteria discussed with the first author after translation. This stage yielded 1198 papers.

Stage 2: 100% of papers included after stage 1 were screened on title and abstract by two independent reviewers (PF and AKT). However, we did not include pragmatics domain as this was the focus of a different review led by other members of the COST Action. Agreement was 93%. This yielded 698 papers. At this stage and each of the subsequent stages, disagreements were discussed and a consensus was reached as per PRISMA guidelines.

Stage 3: Full text screening was completed by the same two independent reviewers. Agreement rate was 94%. This resulted in 244 papers.

Stage 4: Full text screening was completed to include a) papers with a specific focus on dosage characteristics, which were experimentally manipulated or statistically analysed, b) research design levels 1, 2, or 3 (the Oxford Centre for Evidence Based Medicine Hierarchy of evidence). Agreement rate at this stage was 97% and yielded 39 papers.

Stage 5: Full text screening was completed on the above 39 papers and only those that focused specifically on dose form with the necessary controls identified above were included (n=27). See Figure 1 for PRISMA flowchart. Insert Figure 1 about here.

Data Extraction

The data were extracted from the included papers by the first author (PF) and are presented in Table 2. Note that throughout this review we use the term DLD, however the terminology used in Table 2 reflects that which was used in each included paper. All papers were also reviewed by the last author (CMK). For the most part, we used the intention of the authors to categorise the manuscripts. However, in a few incidences we needed to infer the information, for example when categorizing Owen van Horne et al. (2018) (under procedures); Fey et al. 2017 (under intervention context) Haebig et al., 2019 (under intervention context).

There were no disagreements with respect to the coding of dose form components or aspects of dose frequency. Insert Table 2 about here.

Risk of Bias

Studies were appraised by the first and last author, using the Cochrane Risk of bias tool for RCTs (Higgins et al., 2011). We assigned risk of bias ratings of high, low or unclear. Both reviewers rated each article independently and disagreements were resolved by consensus. The risk of bias assessment for each paper is shown in Figure 1 in supplementary materials.

Results

Thirty-three studies were identified in which dosage was experimentally or statistically manipulated, 27 of which manipulated dose form. (Table 2). The majority of studies identified children as having DLD[2] using the following criteria a) a composite score of below 1 standard deviation on a standardized language measure such as the Clinical Evaluation of Language Fundamentals (CELF 4) or the Structured Photographic Expressive Language Test (SPELT-3) b) non-verbal IQ scores within 1 standard deviation of the norm on a test of cognitive functioning (standard score > 85) c) hearing within the normal range (shown by passing a pure tone hearing screening) or no known sensory impairments and d) no known neurological, social-emotional or psychiatric disorders. Interestingly, there was only 1 intervention study (4%) for children with DLD with phonological outcomes, in which dose form was directly manipulated. In contrast there were 12 studies (44%) specific to vocabulary, and 14 (52%) specific to morphosyntax. Thirty-three percent (n = 9) were RCTs, level 2 in the hierarchy of evidence (OCEBM, 2011), 59% (n = 16) were quasi-experimental, (level 3) studies and two studies (7%) were a cohort analytical design (level 3). RCT participant numbers were small,

[2] Note this is not the term used in all papers, as many papers preceded the move from SLI to DLD as per the CATALISE consensus (Bishop et al. 2016)

ranging from six to 30 per group, which raises concerns regarding the interpretation of null findings. The aim of RCTs is to control for differences across groups but with such small sample sizes randomization does not ensure group equity, and is likely to result in biases. There was considerable variation in the risk of bias between papers, with performance bias blinding often impossible to achieve as is the case for most SL interventions. There was a notable increase in controlling for detection bias (i.e. blind outcome measurement) in more recently published studies. Overall, attrition bias and selective reporting were least evident across all papers.

Summary of exploratory findings in relation to dose form

Table 3 presents the dose form comparisons that have been completed across each domain. Insert Table 3 about here.

The first finding of note is the distinct lack of intervention studies in which dose form has been manipulated with phonological outcomes for children with DLD, (see Heikkilä et al., 2018). In general studies of Speech Sound Disorder (SSD) tend to exclude children with DLD and vice versa. Given the high comorbidity in these groups and the more negative prognosis in children with a history of both disorders, in particular with respect to literacy (Pennington & Bishop, 2009; Eadie et al., 2014), this is an important gap in the necessary evidence to inform clinical practice.

There is an inherent difficulty in the interpretation and synthesis of the available evidence due to the high degree in variability of research design across several key methodological choices. Across the discipline of intervention research for children with DLD, there has not been a systematic approach to the examination of the effect of dose form components and how they may interact with age, language level, and other dosage characteristics. In addition, factors such as the nature and timing of outcome measures or the definition of mastery or generalization of a given linguistic skill, have not been methodically

examined. In the following we draw out the key learning we feel *can* be identified within this challenging context and discuss lessons which must be learned if future research is to answer key questions regarding optimal dose form.

Techniques – (The specific actions/ teaching behaviors thought to have benefit.)

Vocabulary.

Semantic and phonological support. With respect to vocabulary techniques (the specific actions/ teaching behaviors thought to have benefit), studies have reported on a semantic teaching focus, phonological focus or a combination of the two (e.g. Korat et al., (2019); Steele et al., (2013)). Overall, the findings suggest that with equivalent doses in a single session, a semantic approach is more beneficial than a phonological or combined approach when learning new vocabulary (Steele et al., 2013). However, in this study learning was measured through tasks which were much more similar to the semantic than the phonological teaching; outcomes were measured immediately post intervention and did not include generalization items; overall dose was low and sample size was small. Therefore, we do not know how treatment effects change with higher doses; if the benefit is maintained over time or is generalizable to other related items; or if the findings would be the same with a larger sample. Within a semantic focus dose forms have included varying levels of support (e.g. dictionary support, giving explanations in the context of the story), the relative effectiveness of which appears to be dependent on the outcome measure used i.e. the clinical goal. While dictionary support appeared to be most effective with respect to word use, providing explanations in the context of the story was more effective in relation to word definition outcomes (Korat et al., 2019). An interaction between semantic supports and children's language level was also reported in that a combined approach incorporating both definition and context was most effective for those with higher levels of language.

Supplementary gesture manipulation. There is some evidence to suggest benefits to the use of supplemental gesture with dose held constant. Using comprehension probes as the outcome, administered pre-, during and immediately post intervention, van Berkel-van Hoof et al. (2019) found that children with DLD learned more pseudo-words in a signed than unsigned condition. In addition, Vogt and Kaushke (2017a; 2017b) report on the learning advantage of iconic compared to attention getting gestures across comprehension, naming and word definition outcomes. However, findings are based on target rather than generalization items, and similar to the van Berkel-van Hoof study, outcomes were measured immediately post intervention. Interestingly, the finding of a supplemental gesture advantage was not replicated (one-week post intervention) in an intervention of similar duration (Lüke et al., 2011) but where the dose was lower and the iconicity of the gestures was not specified. The potential effect of the outcome measure timing is particularly pertinent in the context of recent work carried out by Storkel et al. (2019) showing a 40% drop in word learning 5/6 days post intervention.

Morphosyntax.

Recasts and elicited expression. With respect to morphosyntax, studies have compared various combinations of techniques (e.g. enhanced conversational recasting versus recasting; cueing versus recasting; prompted elicitation with either recasting or modelling versus recasting alone; and recasting and modelling versus recasting alone). Overall, they suggest that apparently quite subtle differences in the cues and recasts provided could affect intervention efficacy. Hence there are a number of techniques which offer potential for manipulation to improve efficiency. However, across studies the impact of expressive practice has rarely been controlled and so is a potential confound meaning further research is needed for definitive conclusions to be drawn.

Eidsvåg and colleagues (2019) manipulated dose form technique by comparing individual morphological error treatment (where children are only exposed to their own target) to treatment carried out in a pair (where children are additionally exposed to their partner's target). Despite hearing their partner's target morpheme modelled during treatment, children in the paired condition showed no significant gains in their ability to produce them. The authors interpreted their findings as an indication that recasts were only effective when directed to a specific child, required the child's active attention and included attempts at morpheme production (i.e. when they were enhanced). The authors acknowledge that there was an element of expressive practice involved for each child when working on their own morpheme, which was absent in the unenhanced recasting condition (in the presence of the paired child's treatment). The authors also counsel caution against over-interpretation due to the study's small sample size. Similarly, Smith-Lock and colleagues (2015) found a cueing hierarchy (that also included recasting) to be more effective than recasting alone in improving grammar production in children with DLD. However, the average age of the cueing group was almost twice that of the recasting group; the cueing condition involved actively eliciting productions whereas the recasting only condition did not; the cueing condition had explicit methods of instruction for some morphemes but not others; and although the authors report on dose, it was extrapolated from a single 15 minute activity from 8 hours of treatment, meaning we cannot rule out the possibility of dose production differences between groups. Findings from Yoder et al. (2011) support the use of prompted elicitation followed by either recasts or models over the use of recasts alone. They found that for children with an MLU of 1.84 (Brown's Late Stage I) the prompted elicitation with modelling/recasting was more effective than recasting alone. Again, it is worth noting that the former approach involves actively eliciting productions whereas the latter does not. It is also interesting to note that although the recasting dose was higher in the recasting only condition, the benefits of expressive practice outweighed the benefits of this

increased dose. The potential impact of expressive practice is also evident in the Proctor-Williams and Fey (2007) study, where accuracy of verb production did not differ between the two treatment conditions: recasting alone versus recasting and modelling. It is significant that children produced the target verbs in both dose form conditions. However, the low dose (given at a rate typical of conversation) may also have prevented differences from emerging. Finally, Hassink and Leonard (2010) examined differences in types of conversational recasting, with preschool children with DLD through a retrospective analysis of transcripts of therapeutic recasting sessions. Findings suggest that non-corrective recasts are associated with better morphological outcomes, than those that are corrective (particularly in the use of third-person singular) and subject-less recasts are associated with poorer outcomes than those in which the subject is included. Findings therefore indicate that the quality of clinician recasts, and the relationship between child and clinician utterances, impacted learning.

Phonology.

Visual supports. The addition of visual supports (in the form of video) was reported in the only study in which dose form was manipulated with respect to phonological training (Heikkilä et al., 2018). Despite measuring numerous outcomes, the only advantage found was in relation to non-word repetition. It is difficult to draw any firm conclusions based on one study (with small numbers) and while we acknowledge the work that has been done in this area with children with speech sound disorders, much more work is required for children with DLD.

Procedure (the combination and order of treatment delivery)

Morphosyntax.

Order effects. There is emerging evidence of the importance of order effects suggesting they do affect the treatment outcome. Plante et al. investigated whether modelling (in the form of auditory bombardment) given before or after enhanced conversational recast treatment, would result in a greater morphological treatment effect. While there were no differences at

group level, individually an increased number of children (86%) were considered 'treatment responders' in the auditory bombardment *after* recast condition than the before condition. Comparisons to a previous study with similar dose, Plante et al. 2014, where only 56% of children were treatment responders support the finding that modelling *after* recasting serves to augment its effects, consolidating children's internal morpheme representations and producing better results than recasting alone.

Van Horne and colleagues (2017; 2018) also investigated order effects in their complexity-based approach, which appears to enhance morphosyntactic treatment effects. They found that those who began treatment with harder to inflect verbs first, made greater gains in past tense accuracy on both target and generalisation verbs, than those who were initially treated with verbs that were easier to inflect. Although the 'hard first' group advantage was no longer evident at follow up on structured probes, when assessed using spontaneous language samples, they continued to show greater gains both immediately and delayed post treatment. Although the age difference was not statistically significant, it may be worth noting the 'hard first' group was on average 9-months older than the easy-first group. The authors conclude that the developmental model (which would seem most intuitive) may not be optimal to achieve generalisation of newly acquired morphosyntactic rules.

Method of Instruction (manner in which techniques are delivered)

Morphosyntax.

Explicit plus Implicit versus Implicit only. Findings from both papers addressing this comparison indicate a learning advantage for explicit instructions in children with DLD with an average age of 7 years. Finestack and Fey (2009) compared a deductive to an inductive approach. We have interpreted the deductive approach as explicit + implicit and the inductive as implicit only but refer the readers directly to the papers for minor differences in how the terms are defined. Findings showed that when compared to the implicit only groups, children

in their explicit+ groups used the novel target morpheme across all probes, and did this more quickly with less intervention. What is particularly noteworthy in the context of the current review is that because the implicit only group were slower to learn the patterns than the explicit+ group, they were exposed to a higher recasting dose. Despite this, the explicit instruction appeared to outweigh the benefits of the increased input dose. In the second, more recent paper, while keeping dose constant, Finestack (2018) again compared explicit + implicit versus implicit only, Again, there was a learning advantage for the addition of explicit rule instruction for children with DLD in this age range.

Intervention Contexts

Vocabulary.

Activity within which the technique is being delivered. Dose form manipulation has also been explored with respect to the context / activity within which techniques are being delivered, for example in spoken/ sung format or using static or video images. The findings point up the potential for contexts to interfere as well as facilitate learning. Smeets et al. (2012) carried out two experiments where video and static stories were presented with and without music and sounds. While they found that video and static stories were equally effective, the presence of music and sounds interfered with children's learning in both contexts, such that the interference was greater for children whose DLD was more severe. In contrast, Kouri and Winn (2006) reported that when words and melody were presented as a single unit (as is the case in a song), music appeared not to be detrimental to quick incidental word learning.

Variability in the linguistic input or materials used. High input variability appears to be advantageous in the vocabulary domain, for children with DLD. The advantage of increased variability is shown in referent exemplars (how an object is represented), language input and changes in context. Findings suggest that increasing exemplar variability in treatment has the potential to improve children's ability to generalize their lexical knowledge and to increase the

efficacy of word learning interventions (Aguilar et al., 2018). Aguilar and colleagues (2018) found that with high variability in the referent, preschool children with DLD had the ability to learn three new words having been exposed to them 18 times over three sessions, and asked to name the items once per session. The findings were maintained 6 weeks post intervention. This was in considerable contrast to previous studies where typically only one object exemplar is given (e.g. Alt & Plante, 2006) and where many more presentations were required for learning to occur (e.g. 40 non-word exposures to learn eight non-words (Gray, Pittman & Weinhold, 2014) or 36 exposures to learn ~ three words (Storkel et al., 2017), (albeit with different outcome measures). Giving children the opportunity to retrieve word names, also appears to aid word learning with respect to nouns (Leonard et al., 2019a) and adjectives (Leonard et al., 2019b), although overall learning was not high in either of these studies. Interestingly, although the receptive exposure dose was constant, the design of both studies was such that there were expressive dose differences between conditions in each study. The findings therefore suggest that given the same receptive exposure dose children will learn words more easily, if given the opportunity to use rather than just hear them. Word retrieval exercises, in which intervening words are presented (and therefore spaced), also assist word learning and retention more than when the context does not change (Haebig et al., 2019). However, because the intervening material also serves to create a more spaced learning condition, it makes it difficult to tease apart the facilitating factors. The implications of massed versus distributed/ spaced learning is discussed in more detail in our review (Frizelle et al., 2021) on the quantitative aspects of dosage.

Morphosyntax.

Variability / specificity in the linguistic input. With the exception of Riches and colleagues (2006), who found that variability of the input did not influence children's morpheme learning (based on only two verbs), other studies suggest that highly variable input

in the therapeutic dose form facilitates grammatical morpheme learning, in children with DLD. The theory posited, as to why variability in the input aids learning, is that it helps children extract the morpho-syntactic rules. It is also in keeping with recent morpho-syntactic priming work with younger children with typical language skills (Krok & Leonard, 2018). The positive effect of variability has been shown in the study by Plante et al. (2014), in which a high (24 unique verbs once) and low (12 unique verbs twice) variability group were compared. The high variability group was the only group to show a treatment effect (albeit modest) and also showed better generalisation of morpheme use. Building on this work Krzemien and colleagues (2020) suggest that when learning to generalise constructions, gradually increasing variability in the input (through progressive alignment) may be more beneficial for children with DLD, than using maximum variability at the outset. There is also an inherent link between complexity and variability in different dose forms. Children are exposed to many examples of easy verbs in their ambient language input. These core verbs are heard and used frequently and are therefore in keeping with a low variability approach. It is thought that they serve as an initial platform from which children may begin to observe a morphological rule, but that it is only when children are exposed to less common verb exemplars that their representations strengthen, and this helps to generalise the rule to a wider range of contexts. Exposure to less common verbs (many of which meet Van Horne's (2018) definition of hard verbs), automatically increases the variability of the input the child hears across intervention and other contexts, therefore making it difficult to tease apart whether the enhanced treatment effect is driven more by the variability or complexity of the input. Given the number of aspects of verb complexity to consider (relative frequency, phonological complexity and telicity - the completeness of the event described by the verb), we agree with Owen Van Horne and colleagues (2018), who suggest that from a clinical perspective, variability may be easier to operationalise than complexity.

One final study, which we found difficult to align with other studies, was carried out by Fey and colleagues (2017). In this study, the linguistic input was specifically manipulated to test the competing sources of input (CSI) hypothesis. The hypothesis proposes that when children use main verbs, not marked for tense, it is because they are treating certain sentence types in their input, as models for declaratives. The authors compared two treatments, one based on the CSI principles and one which did not adhere to these principles (TRAD). A number of techniques were used in both treatments, but it was the specific nature of the linguistic input that was being compared. The CSI group showed greater improvements for one of the three morphemes examined. We refer the reader directly to the paper, for a more comprehensive description of how the input was manipulated.

Discussion

Literature shows that children with DLD can learn from many of the dose form components discussed in this research paper, however our knowledge with respect to how dose form interacts with the quantitative aspects of dosage is in its infancy. We do have some evidence that with careful design of dose form context, changes can occur with lower levels of quantitative dose (see Aguilar et al., 2018). However, this research is just beginning. Hence, it is not yet possible to conclude which are the *optimal and most efficient* dose forms used in interventions. Nevertheless, it is possible to identify some key learning from the review above. With respect to vocabulary, the relative effectiveness of teaching with a phonological versus a semantic focus has not been established and the relative effects of different semantic supports appear to be dependent on the outcome measure. The use of gesture may be advantageous in the short term but we do not know if these effects are maintained. High variability, in relation to how an object is represented, as well as changes in the language input, and context also

appear to enhance word learning and may allow for learning to take place with fewer exemplars.

Research comparing different dose forms in morphosyntax has been more extensive. However, with respect to techniques, studies have not been sufficiently similar to make any kind of summary statements about their relative effects. It seems that whatever the technique, whether the child gets an opportunity to produce the target has a role to play, in improving outcomes. However, opportunities for expressive practice are rarely tightly controlled and become a confound in a number of studies. The order of techniques (auditory bombardment post recasting) or linguistic targets (hard verbs first) also affect the treatment outcome but have been relatively under-researched. In relation to method of instruction, explicit instruction appears to rarely occur on its own but is beneficial to morphosyntactic learning in children with DLD, when added to an implicit approach. Finally, variability in the linguistic input appears to facilitate grammatical morpheme learning in children with DLD.

It is clear from this review that we are a long way from being able to make definitive recommendations, regarding optimal dose forms for interventions for children with DLD. We are yet further away from understanding whether these vary with respect to the child's age, intervention target, or severity or profile of language difficulties. In the following we describe the approach to research we believe is necessary if we are to answer these important questions of relevance to clinical practice, commissioning and funding of services and best outcomes for children with DLD.

Recommendations for future research

Systematic Programme of research

A systematic program of research is required, first, to the manipulation and measurement of dose form, so that effects are measured in isolation. Although clinicians and

researchers often combine techniques in the belief that it will yield better outcomes, combining techniques makes it difficult to tease apart their relative effects. Differences in how techniques are operationalised also causes contradictory findings regarding the relative impact of one technique over another. Taking a more systematic approach, we can begin by measuring dose form *techniques* in isolation and directly comparing one technique with another, we can then gradually build knowledge through measuring the effect of *combining techniques* in varying *procedures* and *contexts* and with different *methods of instruction*.

A systematic approach is also needed to explore interactions between variability in dose form and quantitative dose. Preliminary findings that dose form variability in both vocabulary and morphosyntax could reduce the dose required to achieve an effect (Aguilar et al., 2018; Plante et al., 2014), have important implications for cost-effectiveness and efficiency and suggest that this would be a worthwhile avenue for future research.

This program of research must also examine the impact of different dose form components, across a broader age range, and with differing severity and profiles of language difficulties. Even though children with DLD continue to have difficulties into adulthood, the majority of studies included in this review (with respect to both vocabulary and morphosyntax) focussed on children between 4;0 and 6;0 years. It would also be beneficial to explore any potential interaction between age or language level and dose form. While an interaction between dose form and language level was reported by Korat et al. (2019), Smeets et al. (2012), and Yoder et al. (2011), overall the relationship between the two has been significantly under-researched. A final consideration is whether differing dose form components are more or less effective at different stages in the intervention process. Perhaps explicit methods of instruction are more beneficial at the earlier stages of learning, whilst implicit are more beneficial later, during generalisation and consolidation (Ebbels, 2014).

To complete such a systematic and comprehensive program, including all aspects of dose form, it is clear that a large number of studies are required, each building incrementally on the findings and approaches of prior studies. This must be a cross-laboratory endeavour if we are to gain these insights in a timely manner. Our review suggests there are significant inconsistencies across research teams in how specific dose form components are defined, making the collaboration or synthesis across studies described above highly problematic.

Operationalizing aspects of dose form

It is essential that a consistent approach to the reporting of dose form components be developed and adopted. Interventions that are often similarly labelled, use different techniques or procedures. For example, Proctor Williams (2009) specifies that modelling involves "the presentation of target syntactic forms, without an opportunity for child production" (p. 297). However, this is not how modelling is used by Yoder and colleagues (2011) where prompting to elicit a target structure was followed by either a model or a recast. More recently Eisenberg et al. (2020) suggest that the term model refers "to any exemplar of a target form presented by the clinician, regardless of whether or not the child is asked to attempt production of the target after hearing the model" (p. 206). Terms such as prompting and cueing are also commonly used and can incorporate a range of techniques (e.g. imitation, questioning, commenting), which are not always specified. There is no agreed regulated practice for each dose form technique and the level of detail in describing techniques is often not sufficient to allow faithful replication. For example, in relation to vocabulary studies, where supplemental gesture is used, the iconicity of the gestures is not always described (see Lüke, et al., 2011). In the context of Open Science this is hugely problematic, as without increased clarity in describing each aspect of dose form, replication will remain limited or flawed. Additionally, it is impossible for clinicians to know that they are implementing the approach with sufficient fidelity to achieve

results. In the absence of faithful replications, clinicians and researchers are frequently interpreting results regarding the effectiveness or efficiency of different dose forms, based on a single study and very often with small sample sizes. This is problematic as with such small sample sizes only very large effects can be detected.

A new taxonomy and reporting guidelines

We recommend the development of an agreed taxonomy of dose form components across different domains and the adoption of reporting guidelines across the discipline to aid comparison and application of available evidence. The development of a taxonomy has been carried out in phonological interventions for children with Speech Sound Disorder (Baker et al., 2018) and lessons could be learned from this process for the domains of vocabulary and morphosyntax for children with DLD. With regard to reporting guidelines, for journal articles in which an experimental manipulation or intervention is reported, the JARS (The Journal Article Reporting Standards) (American Psychological Association, 2010) specify eight topics that should be included in an intervention description: intervention content, method of delivery, deliverer, setting, exposure quantity and duration, time span, and activities aimed at increasing compliance or adherence. In addition, the Template for Intervention Description and Replication (TIDieR) checklist and guide has been developed to improve the completeness of reporting and consequently the replicability of interventions (Hoffmann et al., 2014). While these generic guidelines are helpful, given the variation in levels of detail in current reporting on dose form (and indeed other aspects of dosage), it is likely that we need more discipline specific reporting guidelines, to ensure sufficient detail of dose form characteristics are included to move research and practice forward, with regard to optimal dosage characteristics. It is also the case that without an agreed taxonomy detailing each characteristic of dose form, inconsistencies in how different aspects of dose form are implemented will continue to be

problematic, and use of reporting guidelines alone would only go a small way towards addressing the problems in the literature.

Quantitative aspects of dosage. Reporting guidelines are also needed which specify the level of detail required in each of the five dosage characteristics, outlined by Warren et al. (2007). There are four quantitative characteristics - *dose, dose frequency,* and *total intervention duration*, which are then combined to quantify *cumulative intervention intensity*. Within *dose* (the number of properly administered teaching episodes during a single intervention session) both the receptive (input) and expressive (output) dose need to be specified. Each of the dose subcomponents also need to be addressed a) the average rate of teaching episodes per unit of time b) the length of the intervention session, and c) the distribution/ density of episodes over the session. In addition, planned versus actual received dose should be specified along with a minimum threshold of sessions from which dose can be extrapolated, if data from all sessions is not available. Finally, it is only with this level of detail on quantitative dosage characteristics that we can really begin to compare intervention dose form mechanisms.

Outcome measures - definition and timing. Reporting guidelines would also be helpful in creating consistency in features of outcome measurement, such as how outcomes are defined, when outcomes are measured, and whether both target and generalisation items are included. In relation to defining outcomes, at a very fundamental level, more debate is required within the discipline as to what constitutes 'knowing a word', due to the substantial heterogeneity in outcome measurement for vocabulary outcomes. Results are likely to be dramatically different if 'knowing a word' is measured by defining versus naming that word. Choices regarding timing of outcome measurement are also not trivial. Immediate versus delayed testing are measuring two different types of learning: the former measuring children's ability to encode new information, the latter tapping into the level of decay or consolidation that has occurred. Storkel and colleagues (2019) highlighted this, when reporting a 40% drop

688 in word learning a mere 5 to 6 days post intervention. Other studies, reporting a learning
689 advantage for one dose form over another during an intervention, find no such advantage when
690 follow up measures are taken (e.g. Lüke et al., 2011). Contrary findings have also been
691 reported, where initial encoding for children with DLD appeared weaker than their typically
692 developing peers immediately post intervention, but their retention scores were similar one
693 week later (Leonard et al., 2019a).

694 Testing on target probes versus generalisation items is also significantly different in
695 relation to what children have learned and there are examples in the literature, where no
696 learning advantage is shown, for example, on target items, but is shown when measuring
697 generalisation outcomes, particularly in relation to variability (e.g. Aguilar et al., 2018; Owen
698 Van Horne et al., 2018).

699

700 **Conclusion**

701 Clearly, continuing at the current pace of discovery, and using the small samples
702 represented in much of the work reviewed here, we will not complete the program of research
703 necessary to move the field forward, any time soon. To accelerate Scientific progress, we
704 recommend cross-laboratory co-operation and the adoption of internationally recognised
705 standardised reporting of research methods and intervention taxonomies. In addition, we
706 recommend a culture of open science, where interventions are pre-registered and clearly
707 described; accompanying manuals are made available; and where trial data is shared through
708 open access repositories. In this way study comparison, meta-analysis and data-pooling would
709 be enabled; it would serve to accelerate the rate of discovery within the field, and would
710 maximise the potential for learning. Our paper further develops existing operationalisations of
711 dose form and identifies key aspects that we believe should be encoded in such a taxonomy.
712 The benefits of large collaborative research teams have been shown in other areas of science

713 such as in the field of genetics. We advocate that it is time to change research practice and
714 reporting in the field of speech and language pathology, so that we can expedite the delivery
715 of benefits to the lives of those with DLD, through more effective and efficient intervention
716 delivery.
717
718 **References**

719 Aguilar, J. M., Plante, E., & Sandoval, M. (2018). Exemplar Variability Facilitates Retention of
720 Word Learning by Children With Specific Language Impairment. *Language, Speech and*
721 *Hearing Services in Schools*, *49*(1), 72–84. https://doi.org/10.1044/2017_LSHSS-17-
722 0031
723 Alt, M., Meyers, C., Oglivie, T., Nicholas, K., & Arizmendi, G. (2014). Cross-situational
724 statistically based word learning intervention for late-talking toddlers. *Journal of*
725 *Communication Disorders*, *52*, 207-220. https://doi.org/10.1016/j.jcomdis.2014.07.002
726 American Psychological Association, *APA Style Journal Article Reporting Standards (APA*
727 *Style JARS)*. (2010).
728 https://apastyle.apa.org/jars#:~:text=APA%20Style%20Journal%20Article%20Reportin
729 g%20Standards%20(APA%20Style%20JARS)%20are accessed 18 December 2020.
730 Baker, E., & McLeod, S. (2004). Evidence-based management of phonological impairment in
731 children. *Child Language Teaching and Therapy*, *20*(3), 261-285.
732 https://doi.org/10.1191/0265659004ct275oa
733 Baker, E., Williams, A. L., McLeod, S., & McCauley, R. (2018). Elements of Phonological
734 Interventions for Children With Speech Sound Disorders: The Development of a
735 Taxonomy. *American Journal of Speech-Language Pathology*, *27*(3), 906–935.
736 http://doi.org/10.1044/2018_AJSLP-17-0127

737 Bishop, D. V. M., Snowling, M. J., Thompson, P. A., Greenhalgh, T., & CATALISE Consortium.
738 (2016). CATALISE: A multinational and multidisciplinary Delphi consensus study.
739 Identifying language impairments in children. *PLOS ONE*, *11*(7), e0158753.
740 https://doi.org/10.1371/journal.pone.0158753
741 Camarata, S. M., Nelson, K. E., & Camarata, M. N. (1994). Comparison of Conversational-
742 Recasting and Imitative Procedures for Training Grammatical Structures in Children With
743 Specific Language Impairment. *Journal of Speech, Language, and Hearing*
744 *Research*, *37*(6), 1414–1423. https://doi.org/10.1044/jshr.3706.1414
745 Cirrin, F., & Gillam, R. (2008). Language Intervention Practices for School-Age Children With
746 Spoken Language Disorders: A Systematic Review. *Language, Speech, and Hearing*
747 *Services in Schools*, *39*(1). https://doi.org/10.1044/0161-1461(2008/012)
748 Cirrin, F. M., Schooling, T. L., Nelson, N. W., Diehl, S. F., Flynn, P. F., Staskowski, M.,
749 Torrey, T. Z., & Adamczyk, D. F. (2010). Evidence-Based Systematic Review: Effects
750 of Different Service Delivery Models on Communication Outcomes for Elementary
751 School–Age Children. *Language, Speech, and Hearing Services in Schools*, *41*(3), 233–
752 264. https://doi.org/10.1044/0161-1461(2009/08-0128)
753 Connell, P. J., & Stone, C. A. (1992). Morpheme learning of children with specific language
754 impairment under controlled instructional conditions. *Journal of Speech & Hearing*
755 *Research*, *35*(4), 844–852. https://doi.org/10.1044/jshr.3504.844
756 Courtright, J. A., & Courtright, I. C. (1979). Imitative modeling as a language intervention
757 strategy: The effects of two mediating variables. *Journal of Speech & Hearing*
758 *Research*, *22*(2), 389–402. https://doi.org/10.1044/jshr.2202.389
759 Eadie, P., Morgan, A., Ukoumunne, O., Ttofari Eecen, K., Wake, M., & Reilly, S. (2014). Speech
760 sound disorder at 4 years: prevalence, comorbidities, and predictors in a community

cohort of children. *Developmental Medicine & Child Neurology*, *57*(6), 578-584. https://doi.org/10.1111/dmcn.12635

Ebbels, S. (2014). Effectiveness of intervention for grammar in school-aged children with primary language impairments: A review of the evidence. *Child Language Teaching and Therapy*, *30*(1), 7-40. https://doi.org/10.1177/0265659013512321

Eidsvåg, S. S., Plante, E., Oglivie, T., Privette, C., & Mailend, M.-L. (2019). Individual Versus Small Group Treatment of Morphological Errors for Children With Developmental Language Disorder. *Language, Speech, and Hearing Services in Schools*, *50*(2), 237–252. https://doi.org/10.1044/2018_lshss-18-0033

Eisenberg, S. (2014). What Works in Therapy: Further Thoughts on Improving Clinical Practice for Children With Language Disorders. *Language, Speech, And Hearing Services In Schools*, *45*(2), 117-126. https://doi.org/10.1044/2014_lshss-14-0021

Eisenberg, S. L., Bredin-Oja, S. L., & Crumrine, K. (2020). Use of Imitation Training for Targeting Grammar: A Narrative Review. *Language, Speech and Hearing Services in Schools*, *51*(2), 205–225. http://doi.org/10.1044/2019_LSHSS-19-00024

Fey, M. E. (1986). *Language intervention with young children.* College Hill Press.

Finestack, L. H. (2018). Evaluation of an Explicit Intervention to Teach Novel Grammatical Forms to Children With Developmental Language Disorder. *Journal of Speech Language and Hearing Research*, *61*(8), 2062–2075. https://doi.org/10.1044/2018_JSLHR-L-17-0339

Finestack, L. H., & Fey, M. H. (2009). Evaluation of a deductive procedure to teach grammatical inflections to children with language impairment. *American Journal of Speech-Language Pathology*, *18*(3), 289–302. https://doi.org/10.1044/1058-0360(2009/08-0041)

Frizelle, P., Tolonen, A.-K., Tulip, J., Murphy, C.-A., Saldana, D., & McKean, C. (2021). The Influence of Quantitative Intervention Dosage on Oral Language Outcomes for Children

With Developmental Language Disorder: A Systematic Review and Narrative Synthesis. *Language, Speech, and Hearing Services in Schools*, 1–17. https://doi.org/10.1044/2020_lshss-20-00058

Gillon, G. (2000). The Efficacy of Phonological Awareness Intervention for Children With Spoken Language Impairment. *Language, Speech, And Hearing Services In Schools*, *31*(2), 126-141. https://doi.org/10.1044/0161-1461.3102.126

Gómez, R. L. (2002). Variability and Detection of Invariant Structure. *Psychological Science*, *13*(5), 431–436. https://doi.org/10.1111/1467-9280.00476

Haebig, E., Leonard, L. B., Deevy, P., Karpicke, J., Christ, S. L., Usler, E., Kueser, J. B., Souto, S., Krok, W., & Weber, C. (2019). Retrieval-Based Word Learning in Young Typically Developing Children and Children With Development Language Disorder II: A Comparison of Retrieval Schedules. *Journal of Speech, Language, and Hearing Research*, *62*(4), 944–964. https://doi.org/10.1044/2018_jslhr-l-18-0071

Hassink, J. M., & Leonard, L. B. (2010). Within-treatment factors as predictors of outcomes following conversational recasting. *American Journal of Speech-Language Pathology*, *19*(3), 213–224. https://doi.org/10.1044/1058-0360(2010/09-0083)

Heikkilä, J., Lonka, E., Meronen, A., Tuovinen, S., Eronen, R., Leppänen, P. H., Richardson, U., Ahonen,T. & Tiippana, K. (2018). The effect of audiovisual speech training on the phonological skills of children with specific language impairment (DLD). *Child Language Teaching and Therapy*, *34*(3), 269–287. https://doi.org/10.1177/0265659018793697

Higgins, J. P. T., Altman, D. G., Gotzsche, P. C., Juni, P., Moher, D., Oxman, A. D., Savovic, J., Schulz, K. F., Weeks, L., & Sterne, J. A. C. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*, *343*(oct18 2), d5928–d5928. https://doi.org/10.1136/bmj.d5928

Hodson, B. W. (2015). Cycles phonological patterns approach. In C. Bowen (Ed.), *Children's speech sound disorders* (2nd ed, pp. 36-40*)*. Wiley-Blackwell.

Hoffmann, T. C., Glasziou, P. P., Boutron, I., Milne, R., Perera, R., Moher, D., Altman, D. G., Barbour, V., Macdonald, H., Johnston, M., Lamb, S. E., Dixon-Woods, M., McCulloch, P., Wyatt, J. C., Chan, A.-W. & Michie, S. (2014). Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ*, *348*(mar07 3), g1687–g1687. https://doi.org/10.1136/bmj.g1687

Kamhi, A. (2014). Improving Clinical Practices for Children With Language and Learning Disorders. *Language, Speech, and Hearing Services in Schools*, *45*(2), 92-103. https://doi.org/10.1044/2014_lshss-13-0063

Korat, O., Graister, T., & Altman, C. (2019). Contribution of reading an e-book with a dictionary to word learning: Comparison between kindergarteners with and without DLD. *Journal of Communication Disorders*, *79*, 90–102. https://doi.org/10.1016/j.jcomdis.2019.03.004

Kouri, T. A., & Winn, J. (2006). Lexical learning in sung and spoken story script contexts. *Child Language Teaching and Therapy*, *22*(3), 293–313. https://doi.org/10.1191/0265659006ct309xx

Krzemien, M., Thibaut, J.-P., Jemel, B., Levaux, E., & Maillart, C. (2020). How do children with developmental language disorder extend novel nouns? *Journal of Experimental Child Psychology*, *202*, 105010. https://doi.org/10.1016/j.jecp.2020.105010

Krok, W. C., & Leonard, L. B. (2018). Verb Variability and Morphosyntactic Priming With Typically Developing 2- and 3-Year-Olds. *Journal of Speech Language and Hearing Research*, *61*(12), 2996–3009. https://doi.org/10.1044/2018_JSLHR-L-17-0410

Law, J., Garrett, Z., & Nye, C. (2004). The Efficacy of Treatment for Children With Developmental Speech and Language Delay/Disorder. *Journal of Speech, Language, and Hearing Research*, *47*(4), 924-943. https://doi.org/10.1044/1092-4388(2004/069)

836 Leonard, L. B., Camarata, S. M., Pawlowska, M., Brown, B., & Camarata, M. N. (2006). Tense
837 and agreement morphemes in the speech of children with specific language impairment
838 during intervention: Phase 2. *Journal of Speech, Language, and Hearing Research*, *49*,
839 749–770. https://doi.org/10.1044/1092-4388(2006/054)
840 Leonard, L. B., Karpicke, J., Deevy, P., Weber, C., Christ, S., Haebig, E., Souto, S., Kueser, J.
841 B., & Krok, W. (2019a). Retrieval-Based Word Learning in Young Typically
842 Developing Children and Children With Developmental Language Disorder I: The
843 Benefits of Repeated Retrieval. *Journal of Speech, Language, and Hearing*
844 *Research*, *62*(4), 932–943. https://doi.org/10.1044/2018_jslhr-l-18-0070
845 Leonard, L. B., Deevy, P., Karpicke, J. D., Christ, S., Weber, C., Kueser, J. B., & Haebig, E.
846 (2019b). Adjective Learning in Young Typically Developing Children and Children
847 With Developmental Language Disorder: A Retrieval-Based Approach. *Journal of*
848 *Speech, Language, and Hearing Research*, *62*(12), 4433–4449.
849 https://doi.org/10.1044/2019_jslhr-l-19-0221
850 Lüke, C., Rohlfing, K., & Stenneken, P. (2011). Gebärden und kommunikative Mitteilung bei
851 Kindern mit umschriebener Sprachentwicklungsstörung. *Sprache · Stimme · Gehör*,
852 *35*(04), e149–e157. https://doi.org/10.1055/s-0031-1287816
853 Maguire, M. J., Hirsh-Pasek, K., Golinkoff, R. M., & Brandone, A. C. (2008). Focusing on the
854 relation: fewer exemplars facilitate children's initial verb learning and extension.
855 *Developmental Science*, *11*(4), 628–634. https://doi.org/10.1111/j.1467-
856 7687.2008.00707.x
857 Marulis, L., & Neuman, S. (2010). The Effects of Vocabulary Intervention on Young Children's
858 Word Learning. *Review of Educational Research*, *80*(3), 300-335.
859 https://doi.org/10.3102/0034654310377087

Masterson, J. J., & Perrey, C. D. (1999). Training Analogical Reasoning Skills in Children With Language Disorders. *American Journal of Speech-Language Pathology*, *8*(1), 53–61. https://doi.org/10.1044/1058-0360.0801.53

McKean, C., Frizelle, P., Tolonen, AK., Kunnari, S., Murphy, CA., Saldana, D., Law, J., & Josie Tulip, (2017). Interventions for children with primary language impairment: A COST IS1406 systematic review of the influence of dosage in interventions addressing vocabulary, phonology and morphosyntax outcomes. PROSPERO CRD42017076663 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42017076663

Moher, D. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Annals of Internal Medicine*, *151*(4), 264. https://doi.org/10.7326/0003-4819-151-4-200908180-00135

Nicholas, K., Alt, M., & Hauwiller, E. (2018). Variability of input in preposition learning by preschoolers with developmental language disorder and typically-developing language. *Child Language Teaching and Therapy*, *35*(1), 55-74. https://doi.org/10.1177/0265659019830455

OCEBM Levels of Evidence Working Group*. "The Oxford Levels of Evidence 2". Oxford Centre for Evidence-Based Medicine. https://www.cebm.net/index.aspx?o=5653

Owen Van Horne, A. J., Curran, M., Larson, C., & Fey, M. E. (2018). Effects of a Complexity-Based Approach on Generalization of Past Tense – ed and Related Morphemes. *Language, Speech and Hearing Services in Schools*, *49*(3S), 681–693. https://doi.org/10.1044/2018_LSHSS-STLT1-17-0142

Pennington, B., & Bishop, D. (2009). Relations Among Speech, Language, and Reading Disorders. *Annual Review of Psychology*, *60*(1), 283-306. https://doi.org/10.1146/annurev.psych.60.110707.163548

885 Perry, L. K., Samuelson, L. K., Malloy, L. M., & Schiffer, R. N. (2010). Learn locally, think
886 globally: Exemplar variability supports higher-order generalization and word learning.
887 *Psychological Science*, *21*(12), 1894–1902. https://doi.org/10.1177/0956797610389189
888 Plante, E., Ogilvie, T., Vance, R., Aguilar, J. M., Dailey, N. S., Meyers, C., Lieser, A.M., &
889 Burton, R. (2014). Variability in the Language Input to Children Enhances Learning in a
890 Treatment Context. *American Journal of Speech-Language Pathology*, *23*(4), 530–545.
891 https://doi.org/10.1044/2014_AJSLP-13-0038
892 Plante, E., Tucci, A., Nicholas, K., Arizmendi, G. D., & Vance, R. (2018). Effective Use of
893 Auditory Bombardment as a Therapy Adjunct for Children With Developmental
894 Language Disorders. *Language, Speech, and Hearing Services in Schools*, *49*(2), 320–
895 333. https://doi.org/10.1044/2017_lshss-17-0077
896 Proctor-Williams, K. (2009). Dosage and distribution in morphosyntax intervention: Current
897 evidence and future needs. *Topics in Language Disorders*, *29*(4), 294–311.
898 https://doi.org/10.1097/TLD.0b013e3181c29dc0
899 Proctor-Williams, K., & Fey, M. E. (2007). Recast density and acquisition of novel irregular past
900 tense verbs. *Journal of Speech Language and Hearing Research*, *50*(4), 1029–1047.
901 https://doi.org/10.1044/1092-4388(2007/072)
902 Proctor-Williams, K., Fey, M. E., & Loeb, D. F. (2001). Parental Recasts and Production of
903 Copulas and Articles by Children With Specific Language Impairment and Typical
904 Language. *American Journal of Speech-Language Pathology*, *10*(2), 155–168.
905 https://doi.org/10.1044/1058-0360(2001/015)
906 Riches, N. G., Faragher, B., & Conti-Ramsden, G. (2006). Verb schema use and input dependence
907 in 5-year-old children with Specific Language Impairment (SLI). *International Journal*
908 *of Language & Communication Disorders*, *41*(2), 117–135.
909 https://doi.org/10.1080/13682820500216501

Smeets, D. J. H., van Dijken, M. J., & Bus, A. G. (2012). Using Electronic Storybooks to Support Word Learning in Children With Severe Language Impairments. *Journal of Learning Disabilities*, *47*(5), 435–449. https://doi.org/10.1177/0022219412467069

Smith-Lock, K. M., Leitao, S., Lambert, L., Prior, P., Dunn, A., Cronje, S., Newhouse, S., & Nickels, L. (2015). The effectiveness of two grammar treatment procedures for children with DLD: A randomized clinical trial. *Language, Speech and Hearing Services in Schools*, *46*(4), 312–324. https://doi.org/10.1044/2015_LSHSS-14-0041

Steele, S. (2020). Vocabulary Intervention: A National Survey of School-Based Speech–Language Pathologists. *Communication Disorders Quarterly*, *41*(3), 151-161. https://doi.org/10.1177/1525740119827008

Steele, S. C., Willoughby, L. M., & Mills, M. T. (2013). Learning word meanings during reading: Effects of phonological and semantic cues on children with language impairment. *International Journal of Speech-Language Pathology*, *15*(2), 184–197. https://doi.org/10.3109/17549507.2012.700322

Storkel, H. L., Komesidou, R., Pezold, M. J., Pitt, A. R., Fleming, K. K., & Romine, R. S. (2019). The Impact of Dose and Dose Frequency on Word Learning by Kindergarten Children With Developmental Language Disorder During Interactive Book Reading. *Language, Speech and Hearing Services in Schools*, *50*(4), 518–539. http://doi.org/10.1044/2019_LSHSS-VOIA-18-0131

Storkel, H. L., Voelmle, K., Fierro, V., Flake, K., Fleming, K. K., & Romine, R. S. (2017). Interactive Book Reading to Accelerate Word Learning by Kindergarten Children With Specific Language Impairment: Identifying an Adequate Intensity and Variation in Treatment Response. *Language, Speech and Hearing Services in Schools*, *48*(1), 16–30. https://doi.org/10.1044/2016_LSHSS-16-0014

Swisher, L., Restrepo, M., Plante, E., & Lowell, S. (1995). Effect of Implicit and Explicit "Rule" Presentation on Bound-Morpheme Generalization in Specific Language Impairment. *Journal Of Speech, Language, And Hearing Research*, *38*(1), 168-173. https://doi.org/10.1044/jshr.3801.168

Twomey, K. E., Ranson, S. L., & Horst, J. S. (2013). That's More Like It: Multiple Exemplars Facilitate Word Learning. *Infant and Child Development*, *23*(2), 105–122. https://doi.org/10.1002/icd.1824

van Berkel-van Hoof, L., Hermans, D., Knoors, H., & Verhoeven, L. (2019). Effects of Signs on Word Learning by Children With Developmental Language Disorder. *Journal of Speech, Language, and Hearing Research*, *62*(6), 1798–1812. https://doi.org/10.1044/2019_jslhr-l-18-0275

Van Horne, A. J. O., Fey, M., & Curran, M. (2017). Do the Hard Things First: A Randomized Controlled Trial Testing the Effects of Exemplar Selection on Generalization Following Therapy for Grammatical Morphology. *Journal of Speech, Language, and Hearing Research*, *60*(9), 2569–2588. https://doi.org/10.1044/2017_jslhr-l-17-0001

Vogt, S., & Kauschke, C. (2017a). Observing iconic gestures enhances word learning in typically developing children and children with specific language impairment. *Journal of Child Language*, *44*(6), 1458–1484. https://doi.org/10.1017/S0305000916000647

Vogt, S. S., & Kauschke, C. (2017b). With Some Help From Others' Hands: Iconic Gesture Helps Semantic Learning in Children With Specific Language Impairment. *Journal of Speech Language and Hearing Research*, *60*(11), 3213–3225. https://doi.org/10.1044/2017_JSLHR-L-17-0004

Warren, S., Fey, M., & Yoder, P. (2007). Differential treatment intensity research: A missing link to creating optimally effective communication interventions. *Mental Retardation And*

Developmental Disabilities Research Reviews, *13*(1), 70-77. https://doi.org/10.1002/mrdd.20139

Wren, Y., Harding, S., Goldbart, J., & Roulstone, S. (2018). A systematic review and classification of interventions for speech-sound disorder in preschool children. *International Journal Of Language & Communication Disorders*, *53*(3), 446-467. https://doi.org/10.1111/1460-6984.12371

Yoder, P. J., Molfese, D., & Gardner, E. (2011). Initial Mean Length of Utterance Predicts the Relative Efficacy of Two Grammatical Treatments in Preschoolers With Specific Language Impairment. *Journal of Speech Language and Hearing Research*, *54*(4), 1170–1181. https://doi.org/10.1044/1092-4388(2010/09-0246)

Zeng, B., Law, J., & Lindsay, G. (2012). Characterizing optimal intervention intensity: The relationship between dosage and effect size in interventions for children with developmental speech and language difficulties. *International Journal of Speech-Language Pathology*, *14*(5), 471–477. https://doi.org/10.3109/17549507.2012.720281

Figures

Figure 1. Prisma Flowchart showing literature search process.

Supplemental Files

Figure 1. Critical Appraisal of each included study, using Cochrane Risk of Bias Tool.

Table 1. Components of Dose Form and their Definitions

Techniques	The specific actions/ teaching behaviors thought to have benefit
Procedures	The combination and order, of technique delivery

Method of Instruction	The manner in which techniques are delivered i.e. with or without explicit instruction (Explicit versus Implicit)
Intervention contexts	This has 3 sub-components • The activity within which the technique/teaching behaviour is being delivered • Where the activity sits in the child-centred, clinician-directed continuum • The degree of variability / uniformity in the linguistic input or materials used.

Table 3. Dose form comparisons that have been completed across each domain.

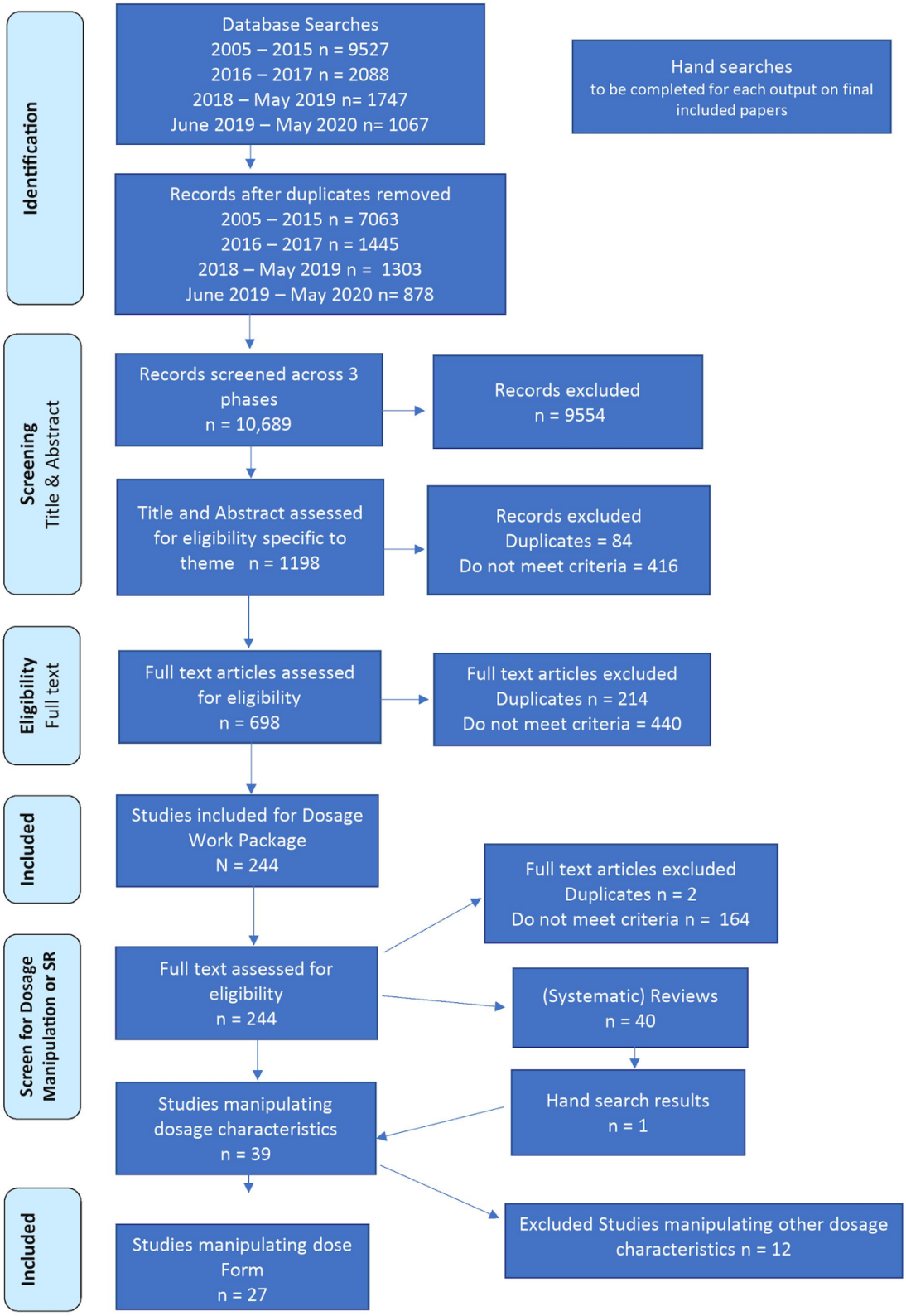
Aspect Manipulated	**Domain**		
	Vocabulary	**Morphosyntax**	**Phonology**
Techniques	Manipulation of Semantic supports	Modelling versus Enhanced conversational recast treatment	Audio-visual speech training versus auditory only
	Manipulation of learning supports – phonological; semantic; combined phonological-semantic; and control.	Dose form in keeping with Competing Sources of Input Hypothesis versus traditional approach not including these features (using story modelling, retell and recasting)	
	Supplementary gesture - signs with speech versus signs alone	Retrospective analysis of differences in types of conversational recasting	
	Supplementary gesture - pseudoword with/without iconic signs	Modelling + recasting versus modelling alone	
	Supplementary gesture - iconic versus attention getting gestures	Recasting versus cueing	
		Grammatical recasting versus prompting followed by a recast or model	

Procedures		Enhanced conversational recast treatment preceded or followed by auditory bombardment	
		Manipulation in the order of verb presentation, (easy to hard, or hard to easy).	
Method of Instruction		Implicit only versus explicit and implicit combined.	
		Explicit and implicit combined versus implicit only- determined by type of auditory prompts given	
Intervention Context	Variability of the physical representation of objects used for each referent in word learning (high versus low variability)	Variability of the linguistic input (high variability versus progressive alignment in exposures to novel construction)	
	Retrieval practice with contextual changes versus immediate retrieval without any intervening linguistic material.	Variability of the linguistic input (high versus low variability in conversational recast treatment).	
	Retrieval practice with contextual changes versus repeated study with no retrieval practice	Variability of the linguistic input (modelling with a noun/pronoun versus noun only frame, in subject /object slots)	
	Using e-books, words illustrated with either static or video images with / without the addition of music and sounds in the video condition		
	Use of story scripts to facilitate word learning, given in sung versus spoken form		

983

984

Figure 1. PRISMA flowchart showing literature search process.



985

Figure 1. Critical appraisal of each included study.

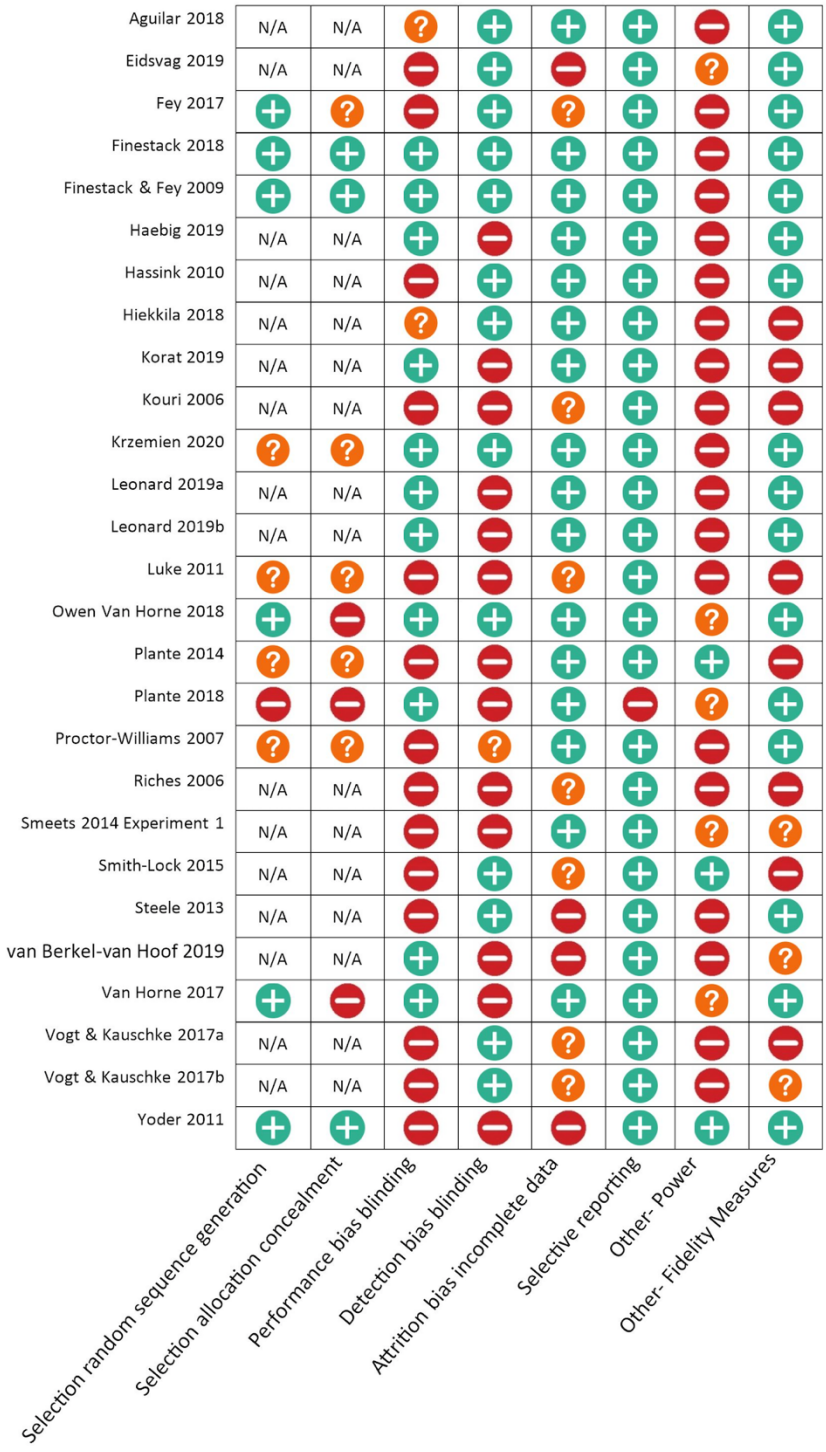


Table 2. Summary of included intervention studies, with vocabulary, morphosyntax or phonology outcomes, in which aspects of *dose form* were manipulated.

Study		Participants (Intervention and comparison)		Treatment					Outcomes		
Aspect Manipulated:Techniques **Domain: Vocabulary**											
Study	**Study design**	**Number**	**Age (M, SD)**	**Dose Form / Intervention context**	**Treatment /control targets**	**Dose Form manipulation**	**Planned/ Received dose**	**Planned/ received Dose frequency**	**Intervention duration and session length**	**Nature and timing of measures**	**Main findings**
1. Korat, O., Graister, T., & Altman, C. (2019).	Quasi Experimental	40 children. 20 with SLI; 20 with typical development All children assigned to each condition	Mean age of 5.58 years (SD = .51)	Word exposure with short dictionary explanation , word exposure with explanation given in the context of the story, or a combination of the previous two. Using animations representing each word meaning – in e-books.	Comprehension and production of 9 verbs	Manipulation of semantic supports for new word learning in e-book activity	Each dose form was given once per session (i.e. short explanation, explanation in story context, combination of the two).	5 sessions at 1-3 day intervals	2 – 3 weeks (sessions 10 minutes in length).	Receptive and expressive probe measures of the target dictionary words (receptive word knowledge test; word definition task; word use task) Administered pre and post (post 1–3 days after the last intervention session)	No significant effect of support between groups. Type of dictionary support did not affect receptive word learning. Dictionary support was the most effective with respect to word use for children with SLI. Explanations in context resulted in the best word definition outcomes. The combined definition approach most

											effective for those with pre-intervention higher levels of language.
2. Lüke, C., Rohlfing, K., & Stenneken, P. (2011)	RCT	12 children with SLI and a semantic lexical disorder (6 children in each group)	Whole group 3;01 to 5;09, M = 57,05 months; SD = 11;08 months Gesture group median 57,05 months Control group median 63;05	Word exposures in the context of play. Prosodic emphasis and semantic elaboration. In the gesture group, the therapist used signs and speech simultaneousl y when naming the figures.	9 novel pseudowords (presented as names of comic figures / 'new friends')	New word learning using simultaneous sign and speech or signs alone	SLT named the figures 12 times session 1 16 times session 2, 18 times session 3	Once weekly	3 weeks (45 minutes per session, including testing)	Picture naming procedure and receptive word learning procedure developed to test active word learning during and post treatment. Pretesting (1 week before the intervention). Naming tests after each intervention session; posttesting 1 week after the intervention had concluded.	No difference between groups in active words learned expressively or receptively at post-test. However, there was a statistical trend in favour of the gesture group.
3. Steele, S. C., Willoughby,	Quasi Experimental	12 children with LI from	LI group = 10;03 years	Word exposures through:	20 words– presented in one of four	Semantic word learning	Control Treatment one exposure	One Tx session (the whole study	One session (length of	Dynamic word learning assessment	Results showed: Children with LI performed

L. M., & Mills, M. T. (2013)		low income backgrounds 11 children with typical language All children assigned to each condition	(9.32 months) TL goup = 10;08 years (6.73months)	Phonological segmentation and blending tasks (modelled by the therapist and then completed by the child). Semantic condition - student friendly definitions, and use of word associations / synonyms by therapist and child. Combined approach- phonological and semantic elements as described.	learning conditions, before reading passages in which the words were embedded.	task in 4 conditions – phonological; semantic; combined phonological-semantic; and control.	Phonological Tx = 5 receptive and 2 expressive Semantic Tx = 5 receptive and 2 expressive Combined Tx + 9 receptive and 4 expressive	took place over 4 sessions)	session not specified)	i.e. Ability to define the words (with response dependant contextual clues) immediately post intervention. If contextual clues did not help children were asked multiple choice questions.	significantly better only in the semantic condition relative to the control condition. Despite hearing the words more frequently in the phonological condition performance was similar to the control the Combined condition performance was similar to the semantic even though words were more frequently presented in the combined.
4. van Berkel-van Hoof, L., Hermans, D., Knoors, H., & Verhoeven, L. (2019).	Quasi Exper-imental	40 children with DLD 26 children with typical development All children assigned to	Children with DLD M= 10;10 (SD = 7.51 months). Age range from 9;3 to 12;2	Pseudo-word and iconic sign exposures using pre-recorded video clips and pictures	Comprehension of 20 pseudo words	Pseudo-word exposures with and without iconic signs One alien from each pair presented in	4 exposures per session (in 4 20 trial blocks)	4 sessions a week 3 were training sessions (1,2 and 3)	1 week, 20 minutes per session	Comprehensio n probes and response time measures administered pre- during and immediately post-	Children with DLD 1)learned more words with sign than without (mean difference of sign vs no-sign = 1.14.

		each condition	Children with typical development M = 9;11 (SD = 9.80 months), Age range from 8;10 to 12;2	pictures are of paired aliens with one distinguishing feature. Words presented in the context of a carrier phrase 'Look an X' in training and 'where is the X' in testing		the signed condition and one in the no-sign condition		3 testing sessions (2,3 and 4)		intervention to assess children's accuracy and speed of understanding target pseudo-words	2)responded as quickly to words with as without a sign. 3) learned significantly fewer words than TD children (M= 4.81 v's 5.98) No significant effect of sign for TD children
5. Vogt, S. S., & Kauschke, C. (2017a).	Quasi Experimental	60 children – 20 children with SLI 20 TD children matched on chronological age (AM) 20 language matched children (LM) All children exposed to each condition	SLI M= 4;06 years SD = 0;7 AM 4;05 years SD 0.3 LM M= 3;03 years SD;16	12 German words (nouns and verbs) for the AM group. 8 for the LM and SLI groups. Nouns represented rare animal species, verbs were intransitive and represented unusual movement types	Word exposures in the context of a story accompanied by either an Iconic or attention directing gesture.	Manipulation of two gesture conditions (iconic versus attention getting)	Children were exposed to each target word twenty times before the first learning assessment and fifty-seven times before the second (post-test).	3 training sessions over 1-2 week period (2 to 3 days apart)	One to 2 weeks (30 minute sessions, 90 minutes in total)	(2017a) Learning was assessed through target focused naming and comprehension tasks. Measurements taken pre, during (immediately after the first training session) and post intervention (two to three days after	For all three groups, observing the iconic co-speech gestures improved children's comprehension and naming of words to a greater degree than observing attention-directing gestures. There was no particular benefit for

6. Vogt, S., & Kauschke, C. (2017b).										completion of the training) (2017b) As above with the addition of a word definition task	children with SLI. Children defined more words trained with iconic gestures than with attention getting gestures. Children with SLI showed increased semantic knowledge on words taught with the iconic rather than attention getting gestures.
Aspect Manipulated: Techniques **Domain: Morphosyntax**											
7. Eidsvåg, S. S., Plante, E., Oglivie, T., Privette, C., & Mailend, M.L. (2019)	Quasi Exper-imental	20 children with DLD (10 per group)	Given for group as a whole M = 5;06, (SD = 5.8 months)	Enhanced conversational recast method. Focused recasts targeting one morpheme per child throughout treatment	Production of third-person singular form; past –ed; auxiliary; infinitive; yes/no questions.	Modelling versus Enhanced conversational recast treatment	Children in paired treatment group heard 24 unique recasts per session directed toward themselves and 24 that were directed	5 times per week (25 days). Treatment days received ranged from 22 to 25	5 weeks (30 minutes per session)	use of target and control morphemes on an elicitation probe and correct use of the child's treatment partner's target	Positive treatment effects shown for both conditions. Children in the paired condition showed no significant gains in their ability to produce their

							to the other child. Children treated individually heard 24 unique recasts per session directed solely to themselves.			morpheme where appropriate. Pre, during and 8 weeks post treatment	partner's target morpheme However moderate to large effect sizes emerged, favouring individual treatment re greater spontaneous use of target morphemes and group treatment re children tending to learn their partner's ambient morpheme. Different results may have emerged with a larger sample.
8. Hassink, J. M., & Leonard, L. B. (2010).	Quasi experimental	17 children with SLI (input analysed for all children)	Mean age not reported. Age range 3;03 – 4;04	1) recasts following child utterances that were prompted by clinicians 2) clinicians' recasts of subject-less	Use of 3rd person singular	Variability in conversational recasting with respect to specific features of the input (retrospective analysis)	12 recasts per session (.8 recasts per minute) 1,152 recasts containing the target form.	four sessions per week	24 weeks (96 treatment sessions). Length of session not stated.	3rd person singular elicitation probes administered mid (after 48 sessions) and post (after 96 sessions) treatment.	Clinicians' use of non-corrective recasts were the most positive predictor of both short and long term gains in the use of 3rd person singular. Recasts of

				sentences, 3) clinicians' noncorrective recasts.							subject-less sentences made a small contribution to children's performance but were associated with poorer outcomes.
9. Proctor-Williams, K., & Fey, M. E. (2007).	Cohort Analytical (treatment words randomly assigned)	26 - 13 children with SLI 13 younger TD participants	SLI group - 7;10 years TD group - 5;6 years	Recasts - in the context of a play based activity	Novel verb learning (6 verbs). Syntactically all verbs were transitive, causative and telic. Phonologically all were single-syllable verbs that marked tense with a vowel shift.	Modelling + recasting v's modelling alone	Planned – Total dose of 30 recasts in both density conditions. Low density = .2 per min High density condition = .5 per minute (no recasts in the first three sessions, last 2 sessions included 5 irregular past tense recasts for each of the three high-density verbs Received - low density .19 per min; High density .47.	Distribution of sessions was not tightly controlled - substantial range in the number of days from the first to the fifth experimental sessions (4 to 44, respectively; M = 14 days; SD = 8.95).	Duration in weeks not specified. 2 Training sessions of 31 minutes - 5 experimental sessions - average 31 minutes.	During the intervention - Correct spontaneous productions of irregular past tense novel verbs in obligatory contexts in Sessions 4 and 5. Post intervention - the number of correct irregular past tense verb productions (maximum 12 per condition)	No difference in accuracy of verb production whether recasts were included as part of the dose form or not.

10. Smith-Lock, K. M., Leitao, S., Prior, P., & Nickels, L. (2015)	Quasi Experimental with cluster randomization	31 children with SLI (17 recasting procedure, 14 cueing procedure)	Recasting group = 119.06 months (SD 8.47) cueing group 60.78 months (SD 3.51)	Adult modelling and child production of targets. Correct child responses treated with modelling correct target back and non-specific feedback. Incorrect child responses treated with either recasting or cueing (which also included recasting but which is not explicitly stated in the paper). Structured activities implemented in small groups	Recasting group: 10 children targeted possessive -s, 3 targeted regular past-tense marker -ed, 4 targeted regular third person singular marker -3s. Cueing group: 8 children targeted possessive -s, 1 targeted regular past-tense marker -ed, and 5 targeted regular third person singular marker -3s.	Recasting versus cueing (differing only in the adults response to the child's error)	Received Dose: Total models heard during one 15-min treatment activity were calculated for each group. Mean number of models heard similar in both groups Recasting group = 86.22 (SD 20.05); Cueing group = 87.67 (SD = 52.92). Extrapolating this figure across the whole program results in cumulative intervention intensity of 2,069 models for recasting and 2,104 for cueing group. Mean number of target utterances per child in the recasting group was 10.08 (SD	once weekly	8 weeks (1 hour sessions - whole class 15 minutes, 3 activities 15 minutes each)	Grammar elicitation test (administered 4 times). Gain between Tests 1 and 2 (pre-treatment gain) compared with gains made between Tests 2 and 3. Test 4, 8 weeks post.	Cueing group made significantly more progress than the recasting group – with a medium–large treatment effect in the cueing group and a negligible effect size in the recasting group. No group differences in maintenance of treatment effects 8 weeks post treatment.

							= 3.16) and in the cueing group was 14.29 (SD = 7.05). Difference not significant.				
11. Yoder, P. J., Molfese, D., & Gardner, E. (2011)	RCT	57 children with SLI (MLT -Milieu language teaching condition - 27 BTR - Broad target recasts condition - 30)	Mean ages not given. 6 of the children were under 36 months. Range 30 - 60 months	For MLT defined as correct teaching episode: adult prompt to elicit from child, followed by an adult production of targeted structure in either recast or model form BTR: prompts to elicit platform utterances, followed by grammatical recasts	MLT- Researchers selected three targets from a language sample on the basis of the absence of examples of specific structures from a list of potential targets typically present in children with the target child's MLU. Targets were replaced when children used three non-imitative examples of the structure in treatment sessions. BTR; The BTR approach does	Grammatical recasting (Broad target recasts BTR) versus prompting followed by a recast or model (Milieu language teaching MLT)	Received: Rate per minute of grammatical recast for BTR (M = 4.3, SD = 0.74). Rate of correct teaching episode for MLT (M = 3.2, SD = 0.57) Dose (per min) was greater for BTR than for MLT t(55) = 5.6, p < .001, d = 1.65. Average proportion of teaching episodes correctly implemented (per min) in the MLT group =	Planned: Three sessions per week (72 sessions) Received: Attendance 96% (BTR M = 68.9, SD = 3.1; MLT M = 68.6, SD = 3.2) of sessions offered.	6 months (24 weeks) 30 minutes per session.	Two 20 minute language samples were collected at 6 time points. Study entry, during the intervention. Immediately post treatment and two follow up maintenance measures (final sample 4 months post). IPSyn score used to reflect syntactic and morphological structures used.	Results revealed a cut point regarding which treatment was most effective. Despite lower MLT dose, for children with an MLU of 1.84 MLT was superior to BTR in facilitating grammatical development. For children with higher MLU, both treatments yielded similar responses.

					not target preselected grammatical structures and uses prompts to elicit children's platform utterances The BTR clinicians recast any 'recastable' child utterance that afforded modelling a developmentally appropriate grammatical structure.		.89 (SD = .17). Average proportion of opportunities (per min) recast in the BTR group = .80 (SD = .07).				
Aspect Manipulated: Techniques **Domain: Phonology**											
12. Heikkilä , J., Lonka, E., Meronen, A., Tuovinen, S., Eronen, R., Leppänen, P. H., Richardson , U., Ahonen,T.,	Quasi Experimental	20 children with SLI (10 in each group)	Group mean age 8 years 9 months in the audio-visual training group, 9 years 1 month in the auditory training group.	Word exposures without noise (50%), with non-speech noise (25%) and with babble noise (25%). Children were required to extract different pieces of	Development of Phonological skills.	Audio-visual speech training v's auditory only	11 blocks of word-picture tasks, each containing 40 words. (440) 10 blocks of word-letter tasks, each containing 40 words (400). 6 blocks of word-syllable	5 times a week	6 weeks - 10 to 15 minutes per session (between 5 and 7.5 hours)	Neuro-psychological and behavioural assessments completed Pre and post training NEPSY-II Phonological Processing NEPSY Repetition of	Both groups improved in their phonological processing skills. No post treatment differences in how the two groups performed overall.

Tiippana, K.(2018).				information from the exposures (word, syllable, phoneme). Intervention delivered through use of Neuro-behavioural systems software			tasks, each containing 40 words. (240). One session consisted of one or two blocks, depending on the response speed of the participant.			Nonsense Words	Repetition of nonsense words the only outcome measure on which there was a significant difference between the two groups, in favour of the audio-visual condition.
Aspect Manipulated: Procedure **Domain: Morphosyntax**											
13. Owen Van Horne, A. J., Curran, M., Larson, C., & Fey, M. E. (2018).	RCT	20 children with DLD (2 groups – 10 easy first, 10 hard first)	easy first 64.7 months (23.76) hard first 70.8 months (22.77)	Sentence imitation, corrective feedback, observational modelling, morpheme exposures within a syntax story and recasts during play based focused stimulation.	Use of past tense morpheme - ed in 30 target verbs	Complexity based approach, manipulation in the order of verb presentation, easy to hard, or hard to easy.	Planned per session: 10 sentence imitation items (two per verb) with corrective feedback. 25 observational modelling examples (five per verb; A minimum of 15 exposures (three per verb); 15 to 25 regular past tense –ed recasts (three	One to three visits per week (scheduling family dependant)	A maximum of 36 visits regardless of progress made. Range 12 – 36. Session length not explicitly stated, approx.-imately 30 minutes based on timing of session components.	Children's performance on past tense –ed assessed using structured probes and narrative retells, prior to intervention immediately after intervention and 6–8 weeks after intervention.	On structured probes, the hard group first advantage (2017) no longer evident at follow up. In spontaneous language samples, hard group first showed greater gains post treatment and at follow up. No generalisation to untreated morphemes.

							to five per verb)				
14. Plante, E., Tucci, A., Nicholas, K., Arizmendi, G. D., & Vance, R. (2018)	Quasi Experimental	28 children with DLD (14 in each group)	5;03 years (range 4;03 to 6;02 years)	Enhanced conversational recast and auditory bombardment	Expressive morphological targets (chosen on the basis of morpheme use less than 30% of the time in obligatory contexts)	Enhanced conversational recast treatment preceded or followed by auditory bombardment	48 treatment doses per session. 24 presented as recasts, and 24 occurred during auditory bombardment. Cumulative intervention intensity 408-600 across children m=552	Once per day, 5 times per week	5 weeks (total intervention duration of 25 days) 30 minutes per session.	Learning tracked through baseline and generalization probes (given 3 times a week). And spontaneous use of target morphemes during treatment	No significant difference between Bombardment First and Last conditions on: morpheme use in probes; spontaneous morpheme use; unique utterances containing target morphemes. More children showed response to treatment in bombardment last condition.
15. Van Horne, A. J. O., Fey, M., & Curran, M. (2017).	RCT	18 children with DLD (10 easy group first, 8 hard group first)	Easy first 63.1 months (23.02) Hard first 72.75 months (18.48)	Sentence Imitation, structured prompting, observational modelling, focussed stimulation and recasting Therapy was play based	Use of past tense morpheme - ed in 30 target verbs	Complexity based approach, manipulation in the order of verb presentation, easy to hard, or hard to easy.	First Tx visit Structured prompting and sentence imitation resulted in children hearing 20–30 examples of the past-tense –ed (four to six	One to three visits per week (scheduling dependant on family)	A maximum of 36 visits regardless of progress made. Range 12 – 36. Session length not explicitly stated, approx.-imately 30	Sentence completion probes were administered pre- post and during treatment. Probes also used puppet shows and obligated the use of the	Gains in target verb accuracy significantly greater for hard-first group. If analysis included trained verbs only then no group differences.

				and through the use of syntax stories.			examples per verb). Those who didn't meet 80% criterion got 2nd Tx visit where they heard 65- 85 models or recasts at a rate of 0.6 to 1.0 recasts/min during the focused stimulation portion of the treatment sessions		minutes based on timing of session components.	past tense. Both treatment and generalisation sets of verbs were measured.	Gains in generalization verb accuracy significantly greater for the hard-first group Hard group first also made greater gains on all untreated verbs. No differences in time in therapy or progress made on the verbs that were targeted during intervention.
Aspect Manipulated: Method of Instruction **Domain: Morphosyntax**											
16. Finestack, L. H. (2018).	RCT	25 children with SLI. Implicit only 13 Explicit Implicit combined 12	EI group M = 6.77 years (SD .66) IO group M = 7.35 years (SD 2.46)	Computer presentation Explicit= models, elicitation using cloze procedures, feedback + explicit instruction regarding the rule guiding use of the	acquisition, maintenance, and generalization of the production of 3 different novel grammatical forms (relating to gender, aspect and person)	Implicit and explicit method of instruction/ procedure	morpheme count - 25 for the gender morpheme, 40 for the aspect (habitual action) and 38 for the first person morpheme	5 sessions over a 9 day period (range = 7.08 days to 10.58 days to complete teaching sessions)	Each participant completed up to five teaching sessions (20 minutes long) for each of the three grammatical targets. Max 15 *20 = 300 min or 5	Acquisition, maintenance and generalisation probes. Pre, post and follow up. Follow up (generalisation probe) 1 week post intervention	A significant learning advantage for the E-I group on acquisition, maintenance, and generalization probes when performance was combined across the 3 targets.

				novel target form. Implicit = as above but explicit instruction replaced by a filler statement.					hours. Or taking the average 13.5*20 =270 minutes or 4 1/2 hours		Re individual targets significant differences emerged in favour of the E-I group on gender morpheme only Controlling for dose, explicit instruction enhanced morphological learning.
17. Finestack, L.H., & Fey, M.H. (2009)	RCT	32 children with SLI (16 in each group)	Deductive group M = 87.94 months SD 7.71. Inductive group M = 88.31 months SD 8.32	Computer presentation Deductive: Modelling of structure, auditory prompting, production of morpheme (using sentence cloze techniques) followed by recasting if production incorrect. Auditory	Novel marking of subject verb agreement, limited to 3rd person singular BE in English	Deductive (explicit) v's inductive (implicit) types of auditory prompts given	20 models of the structure 10 auditory prompts to produce the morpheme Number of recasts following incorrect production dependant on child's response (not reported) Generalisation probe 30 items	4 sessions intended to occur within a two week period. Mean number of days between individual treatment sessions for both groups combined was 2.75 (range = 1–11; Deductive: M = 2.73,	The mean number of days required to complete all four treatment sessions for both groups was 9.25 (range = 4–16 days; Deductive: M = 9.19, range = 4–16; Inductive: M = 9.31, range = 4–16).	Teaching probe, generalization probe and maintenance probes were administered during and immediately post treatment	More children in the deductive group successfully used the novel morpheme in the teaching probe (10 v's 3), the generalization probe (10 v's 3), and the maintenance probe (7 v's 2) - despite fewer recasts in deductive group

				prompt was rule based Inductive: as above, but rule based prompt was replaced by a filler prompt				range = 1–11; Inductive: M = 2.77, range = 1–7).	Session length not stated.		
Aspect Manipulated: Intervention Context **Domain: Vocabulary**											
18. Aguilar, J. M., Plante, E., & Sandoval, M. (2018)	Quasi-Exper-imental	18 children with SLI (9 per group)	High variability group 59.4 months (5.7) No variability group 57.2 months (4.3)	Word exposures – through the presentation of physical objects (with and without variability	Comprehension of 8 target vocabulary words	The variability of the physical representation of objects used for each referent.	6 exposures per session / procedural fidelity for number of presentations = 95%	3 training sessions once weekly	6 weeks including baseline and outcome measures. 3 weeks intervention. 12.5 minutes average per session	Comprehensio n probes administered during and after intervention) designed to measure generalisation (ability to identify the object using new object exemplars of the same class)	High Variability group correctly identified more generalization items than the No Variability group at retention test, but not during intervention.
19. Haebig, E., Leonard, L. B., Deevy, P., Karpicke, J., Christ,	Quasi-Experimental	32 children (16 typically developing and 16 with DLD – all children assigned to	TD M = 61.58 months, SD = 5.16; DLD M = 59.60 months, SD = 4.43	Computer presentation Study trial: Word exposure, word	Word learning – 12 novel words (exotic plants and animals)	Retrieval practice with contextual changes (RRCR) versus immediate retrieval	Planned - The total number of exposures of each novel word was 24, and each word meaning was	Intervention carried out over 4 days (2 X 2 day periods)	Each 2 day intervention period was 2 weeks apart. 2 X 10 minute	Word form recall and meaning recall (e.g. What's this called? What does this one like?)	Although RRCR had a reduced expressive dose - Children with DLD achieved an average score of 2.5 points

S.L., Usler, E., Kueser, J.B., Souto, S., Krok, W., & Weberb, C. (2019).		two word learning conditions)		definition i.e. what the object liked, in the presence of a picture referent, Retrieval trial: picture prompts to recall word name and definition. For words in the RRCR condition, retrieval trials for a word occurred only after two other words had been presented. For words in the IR condition, all retrieval trials immediately followed a study trial of the same word.		without any intervening linguistic material (IR)	heard eight times. Each word form and meaning had six retrieval opportunities. Received - Number of exposures constant for each condition Number of words produced were more frequent in the IR schedule (n = 1,033) than in the RRCR schedule (n = 587).		blocks each day. 40 minutes for each set of 6 words. 80 minutes total	Post treatment and follow up. Follow up testing one week post 2 day intervention. Additional form-referent link recognition test at follow up.	higher in the RRCR condition than in the IR condition. Findings indicate that word retrieval exercises in which there are intervening words presented, assist word learning and retention more than repeatedly retrieving and producing a word with no contextual change.
20. Leonard , L. B.,	Quasi-Experimental	10 children with DLD	Children with DLD M= 63.4	Computer presentation	Retention of 8 novel	Retrieval practice with	Each word in each condition	Treatment completed	4 sessions over a two	Recall (of word form	Both groups showed better

Karpicke, J., Deevy, P., Weber, C., Christ, S., Haebig, E., Souto, S., Keueser, J.B. & Krok, W. (2019).		10 children with typical development All children assigned to both conditions	months, SD = 6.2 Children with typical development M = 63.2 months, SD = 4.89	Study trial format – word exposures in the presence of a picture referent and in the context of a 3 sentence sequence in which the novel word name and definition were integrated. Retrieval trial format - Child shown picture and heard a pre-recorded question what's this called (name) and what does this one like? (definition) RRCR condition followed a	consonant-vowel – consonant word forms and their meaning – nouns (targeted as two sets of 4 words Words taken from Storkel and Lee (2011) matched on phonotactic probability and neighbourhood density	contextual changes (RRCR) versus repeated study with no retrieval practice (RS) First retrieval for each word immediately followed the study trial (no other novel words intervening). Subsequent retrieval in the RRCR condition occurred after 3 intervening novel words	was heard and defined 48 times. (3 sentence sequence X 16 trials)	over 2 consecutive days for each set of 4 words – 1 week apart	week period. Session length approximately 25 minutes to include a 5 minute break (2 blocks of 10 minutes on day 1 and 2 blocks of 10 minutes on day 2)	and definition) and multiple choice comprehen-sion task. Both administered 5 minutes post the 4th intervention block and 1 week later.	word form recall following the RRCR condition than in the RS condition – large effect size All but one child with DLD recalled more words in RRCR than in RS condition. Both groups showed better word meaning recall following the RRCR condition than in the RS condition Despite weaker initial encoding, 1 week post intervention there were no differences in retention between the DLD and TD groups

				study-retrieval - study protocol RS condition involved 3 consecutive study trials							
21. Leonard , L. B., Deevy, P., Karpicke, J. D., Christ, S., Weber, C., Kueser, J. B., & Haebig, E (2019)	Quasi-Experimental	14 children with DLD 13 children with typical development All children assigned to both conditions	Children with DLD M= 62.64 months, SD = 5.41, range 53 – 71 months Children with typical development M = 62.54 months, SD = 6.34, range 51 – 71 months	Computer presentation Study trial format – word exposures in the presence of picture referents and in the context of a 3 sentence sequence in which the novel word is integrated. Retrieval trial format - Child shown picture and heard a pre-recorded request to give the	Recall and recognition of 8 novel adjectives (targeted as two sets of 4 words) Generalisation of novel adjectives to new referents	Retrieval practice with contextual changes (RRCR) versus repeated study with no retrieval practice (RS) First retrieval for each word immediately followed the study trial (no other novel words intervening). Subsequent retrieval in the RRCR condition occurred after 3 intervening novel words	44 exposures across two days of learning	Treatment completed over 2 consecutive days for each set of 4 words – 1 week apart	4 sessions over a two week period. Session length approximately 25 minutes to include a 5 minute break (2 blocks of 10 minutes on day 1 and 2 blocks of 10 minutes on day 2)	Recall (of word form, applied to referents used in the treatment and generalisation items). Multiple choice comprehen-sion task. Recall assessed 5 minutes post the second session and 1 week later Recognition / multiple choice task assessed 1	For both groups of children, recall was higher for adjectives learned in the RRCR condition than in the RS condition at both time points. Large effect for DLD group For recognition the DLD group showed greater accuracy for adjectives learned in the RRCR condition than those in the RS condition.

				appropriate adjective to complete the sentence, as in “Tell me about the cat. The cat is very ___. RRCR condition followed a study-retrieval - study protocol (with the exception of the first four items for which there were two study trials) RS condition involved a single study trial (with the exception of the first four items for which there were two study trials)						week post intervention	No effect of condition for recognition in the TD group

22. Smeets, D. J. H., van Dijken, M. J., & Bus, A. G. (2012) Experiment 1	Quasi Experimental	29 children with SLI All children assigned to each condition	(M = 69.34 months SD = 5.92)	Word exposures through electronic stories (static and video with music and sounds).	42 words (half of which were nouns)	Using e-books, words illustrated using either static or video images with the addition of music and sounds in the video condition.	4 exposures per word	Twice weekly	Intervention was carried out over two periods - each lasting 4 weeks (8 weeks in total). Length of session 20 minutes by implication but not specified.	Pre and post intervention, knowledge of target words was assessed using a sentence completion task.	Children learned 23% of words targeted in the intervention. Static books were more effective than those using video.
Experiment 2	Quasi Experimental	23 children with SLI	(M = 71.56 months SD = 7.15)	Word exposures through electronic stories (static and video with and without music and sounds).	72 words	Using e-books, words illustrated using either static or video images Both conditions with and without music and sounds.	4 exposures per word	Twice weekly	24 weeks (72 sessions) 30 minutes per sessions	Target vocabulary test as above. (post was 3 to 4 days after the last story exposure) with the addition of the CELF 4 NL, nonword repetition task and digit span from the CELF 4.	Video and static stories were equally effective in children's word-learning. Music and sounds interfered with children's learning in both contexts The effect was moderated by children's language ability.
23. Kouri, T. A., & Winn, J. (2006).	Cohort Analytical	16 children with SLI (12 of which were	M= 4;01 years. Range 3;06 to 5;01	Word exposures through story- telling	Comprehension production and generalisation of 8 novel nouns	Use of story scripts given in sung or spoken form	Words modelled 5 times through the story. All 5	2 Sessions within five days of each other	1 Week (50 – 60 minutes long)	Lexical production, comprehension and	No significant main effects or interactions between

		considered mildly development -ally delayed). These children meet the new criteria for DLD. All children assigned to each condition.		and act out. Character manipulation (by children) during story telling.			exposures were spoken or 2 were spoken and 3 were sung.			generalization probes were administered in each treatment session (8 other objects closely resembling the target items were constructed for use in the generalization probes)	numbers of target or generalization items comprehended in sung and spoken conditions in either session. More spontaneous initiations of novel lexical items produced in the second than first session in the sung condition only.
Aspect Manipulated: Intervention Context **Domain: Morphosyntax**											
24. Krzemien, M., Seret, E., & Maillart, C. (2020)	RCT	30 children with DLD 30 children with TD matched on a measure of sentence comprehension Children randomly assigned to	Children with DLD M= 9,11, SD = 1;08 Language matched children M = 7;07, SD = 2;01)	Exposure to the novel construction in two conditions (high or progressive variability) associated with a video in which figurines performed	Comprehension and generalisation of a novel construction of the form NP-NP- V (the first NP is the character who appears, the second NP is the place where it appears and the V specifies how	Variability of the input High variability condition – sentences had no words in common Progressive alignment condition – the second, third, fourth,	Constructions presented in 8 sentences, twice per video - 16 exposures	A single training session	Single session, approximately 15 minutes in duration	Generalisation video probes administered immediately post intervention (6 constructed according to the novel construction, 6 transitive sentences) All sentences had no words	Children in both groups performed better in the progressive alignment condition than in the high variability condition – no significant differences between groups

		one of two conditions		various actions	the character appears)	and fifth sentences had words in common, sentences became progressively distinct.				in common with the stimuli used in the training phase.	Both groups performed better on the transitive than novel construction. For children with DLD, performance on the novel construction was at chance in progressive alignment condition and below chance in the high variability condition.
25. Fey, M. E., Leonard, L. B., Bredin-Oja, S. L., & Deevy, P. (2017)	RCT	20 children with SLI (11 TRAD group, 9 CSI group)	45 months	Story modelling, retell and recasting with 1) no competing sources of input 2) ½ to 1/3 presented in competing interrogative form	Production of 3rd person singular and auxiliary is	A dose form in keeping with Competing Sources of Input Hypothesis versus traditional approach not including these features.	CSI intervention: 10 trial *is/was* comprehension game 12 declarative *is* models 8 declarative *is* recasts 10 trial *does/did* comprehension game (tense contrast focus) 12 declarative *3s* models	2 sessions per week	12 weeks – 30 to 40 minutes per session	Morpheme production and comprehension probes which were administered pre-treatment, at midpoint (after 6 weeks) and post intervention (after a	In keeping with the CSI hypothesis the CSI group showed greater gains in their use of *is* (with a large effect size). Contrary to the CSI hypothesis there were no significant group differences in the production of *3s.* This was

							8 declarative *3S* recasts TRAD intervent: 10 trial *is/was* comprehension game 6 declarative *is* models, 6 interrogative *is* models 4 declarative *is* recasts, 4 interrogative *is* recasts 10 trial *does/did* comprehension game (semantic focus) 12 declarative *3S* models, 6 interrogative *does* models 8 declarative *3s,* 4 interrogative *does* recasts Actual received very close to what was planned			further 6 weeks).	also the case for the control morpheme *-ed*.

26. Plante, E., Ogilvie, T., Vance, R., Aguilar, J. M., Dailey, N. S., Meyers, C., Lieser, A.M., & Burton, R. (2014)	RCT	18 children with language impairment 9 per group	low variability group M = 5;02, high variability M = 4;11.	Recasting	morphological deficits	Manipulation of variability in the linguistic input - high versus low variability in conversational recast treatment.	24 for both treatment conditions (high and low variability) Cumulative intervention intensity 408-600 across children m=552	Planned: 5 times per week Received: 20 to 25 sessions. Low variability group mean 23 days, high variability mean 22.9 days	5 weeks and 2 days. 30 minutes per session	Target and control morphological probes, total number of inflected verb tokens and verb types used spontaneously in treatment. Probes administered pre, during and post treatment.	Only those in high variability condition showed significant change in their use of target v's control morphemes. More children showed strong treatment effect in the high variability condition. High variability group spontaneously produced significantly more inflected verb types.
27. Riches, N. G., Faragher, B., & Conti-Ramsden, G. (2006)	Quasi Experimental	24 children with SLI matched to 23 typically developing children on overall language abilities.	SLI - mean age 5;6 years TD - mean age 3;5 years	Modelling act out task, questioning (elicitation question to use verb in any frame, elicitation question to use verb in transitive frame)	Generalising of verbs from a non-transitive to a transitive frame.	Modelling with either a noun/pronoun or noun only frame, in the subject /object slots)	Planned and received - 12 verb exposures during each session. (36 times over the three training sessions). In total, there were 216 verb presentations (36x6).	3 intervention sessions (frequency not specified)	Intervention duration and session length were not specified.	Probe in which the children heard novel verbs in a non-transitive frame and were required to produce them in a transitive frame.	The likelihood that the children generalized the novel verb to a transitive frame was not dependant on the frame used during the training sessions.

				Play based treatment							As expected more pronoun responses were produced in the mixed condition. The children with SLI showed a greater degree of input dependence than the TD group