

Supplemental Material S1. Summary of included intervention studies, with vocabulary, phonology, or morphosyntax outcomes, in which aspects of *dose frequency* were manipulated.

Study		Participants (Intervention and Comparison)		Treatment				Outcomes			
Study	Study design	Number	Age (<i>M, SD</i>)	Dose Form/Intervention context	Treatment/control targets	Dosage manipulation	Planned/Received dose	Planned/received Dose frequency	Intervention duration and session length	Nature and timing of measures	Main findings
1. Balthazar, C. H., & Scott, C. M. (2018)	Quasi Experimental	30 children with SLI Once weekly <i>n</i> = 14 Twice weekly <i>n</i> = 16	Once weekly group 11;06 years Twice weekly group 12;01 years	Modelling, repetition, manipulation of a complex sentence	Production of adverbial clauses, object complement clauses and relative clauses	Cumulative intervention intensity	Planned - 30 stimulus presentations per session (15 or modelling and repetition and 15 of sentence manipulation). Received for once weekly group 26 items per session. Twice weekly 28 items per session	Once weekly or twice weekly	9 weeks (40 to 60 minutes per session)	Complex sentence probes (before, during & after treatment). Standardized language tests and criterion referenced tasks. Pre and post intervention.	Treatment effective as measured by the sentence production probes. No advantage for the higher dosage group on any oral language measure.
2. Bellon-Harn, M. L. (2012)	RCT	12 children with SLI Concentrated <i>n</i> = 6 Distributed <i>n</i> = 6	Both groups (concentrated and distributed) 4.61 years	Wh questions, expansions, cloze procedures (at varying levels of semantic complexity), models. Scaffolded language intervention in the context of book reading.	Expressive semantic and morphologic abilities	Dose Frequency	Average number of cloze procedure, expansion, or model used per minute ranged between 7 and 13 during each sampled session for all children. Authors note that - in a scaffolded-language therapy, there is no predetermined script or target. As	Concentrated group - 4 times per week. Distributed group - twice a week. Received dose frequency was as planned	6 weeks (4 times a week) 12 weeks (twice a week) 20 minutes per session	Language sample analysis and expressive language probes. Pre and post intervention	Positive outcomes following both treatment schedules, no differences in how children performed in either the concentrated or spaced treatments

							such, questions remain about the frequency of linguistic forms within each cloze procedure, expansion, and model.					
3.	Bellon-Harn, M. L., Byers, B. A., & Lappi, J. (2014)	RCT	12 children with SLI (from low SES area) 24 sessions <i>n</i> = 6 42 sessions <i>n</i> = 6	4 times weekly group - 4.63 years 3 times weekly group - 4.78 years	Cloze procedures, expansions, models - Interactive Book Reading	Micro-structure components of narrative	Total intervention duration	Based on 20% sample, Average number of cloze procedures, expansions, or models used per minute ranged between 7 and 13. Average number of coordinating clauses between 0.2 and 3 times per minute Average number of subordinating clauses between 0.6 and 3 times per minute	4 times per week (yielding 24 sessions in total) or 3 times per week (yielding 42 sessions in total)	6 weeks or 14 weeks - 20 minute per session	Language sample analysis. Week 1, midpoint and final week of intervention. Measurements from samples: Frequency with which children used co-ordinate and sub-ordinate clauses as well as the number of words within clauses.	Results indicated positive outcomes, but no group differences between those who received 24 sessions v's those who received 42 sessions of treatment.
4.	Justice, L. M., Logan, J., Jiang, H., & Schmitt, M. B. (2017)	Cohort Analytical	233 children with language impairment.	76 months (ranged from 59 to 96 months)	Not specified as it depended on the target. Business as usual treatment carried out within the public schools system in the USA	One of 9 language focussed targets (grammar, communi-cative functions, discourse, narrative, listening comprehension Abstract language, meta-linguistics, literacy) 3 speech	Treatment intensity (dose and frequency)	Children received language- focused treatment for about 12 min per session (mean = 11.8, <i>SD</i> = 4.73; range = 0.94–22.69), correspond- ing to about 49% of children's time in	1.3 sessions per week (range .5 to 4.1) Planned - 40.8 minutes per week Received - an average of 36.11 min/week an average of	Estimates of each child's treatment intensity was based on an average of 28 weeks of the current academic year (range = 7–39 weeks)	The four core subtests of the CELF-4 (con- cepts and following directions, word structure, recalling sentences, and formulating sentences)	children receiving high frequency/low dose, or low frequency/high dose treatment had better outcomes than those receiving high frequency/high

					focused (articulation, phonology, fluency, voice) 2 other (behaviour management, transitioning activities and null: no discernible target		treatment Children received an average cumulative intervention intensity of 1092.3 min (<i>SD</i> = 609.10, range = 66.45–3505.86 min) over an academic year of services.	46.4 treatment sessions in total across the academic year (<i>SD</i> = 16.56; range = 16–154), corresponding to about one session per week		were administered in the fall and spring of the academic year. The vocabulary subtest from the Woodcock Johnson III Tests of Achievement	dose, high frequency/average dose or low frequency/low dose treatment.
5. Meyers-Denman, C. N., & Plante, E. (2016)	RCT	16 children with SLI Massed <i>n</i> = 8 Spaced <i>n</i> = 8	Group A (massed) 5;03 years Group B (spaced condition) 5;04 years	Focused conversational recasts targeting a single morpheme. Focused recasts that used vocabulary that was unique to that recast and was administered to a child who was attending (i.e., looking at the clinician) during the recast)	One expressive morpheme different for each child. In Group A (massed condition) past -ed x3, is - ing x2, 3psx1, she x1, hasx1. In Group B spaced condition 3x is-ing, 1x3ps,1xpast, 1xdoesn't, 1x she,1xhas	Dose Frequency (intervention given in massed or spaced conditions)	Planned: 24 conversational recasts per day targeting a specific grammatical morpheme, regardless of whether these were administered in the massed or spaced condition. Overall rate of delivery controlled across spaced and massed conditions at eight recasts per each 10-min block of time (one recast every 1.25 min.)	Group A: 5 times per week Group B: 15 times a week	5 weeks (21 - 26 days, mean 25 days) Group A: One session of 30 minutes Group B: 3 X 10 minute sessions within a 4hr period	Baseline, end treatment, follow up Generalisation probes administered post treatment and at follow up – measuring child's use of the target/or control morphemes during a play based activity that obligated the use of the morphemes with untreated lexical items.	Results indicated a significant improvement in morpheme production in both dose frequencies with no change in untreated morpheme use. No differences in the effect of treatment for the concentrated or spaced conditions.

							Received: cumulative intervention intensity of approximately 600 conversational recasts containing the target morpheme - range 504-624 recasts				
6. Plante, Mettler, Tucci, & Vance, (2019)	Quasi-Experimental	20 children with DLD High density <i>n</i> = 10 Low density <i>n</i> = 10	<i>M</i> = 5;0 years Range 4;01 to 5;11	Enhanced conversational recast treatment – in the context of free play and dialogic book reading	Morphological forms used (spontaneously or elicited) less than 30% of the time were assigned as treatment or control Including -ed, 3 rd person – s, Aux. is, possessive	High density or low density of Enhanced conversational recast treatment	High density – 24 recasts administered in the first 15 min of a 30 minute session (1.6 per min) Low density- 24 recasts over 30 minutes (.8 per minute) Cumulative intervention intensity of 528 – 600 across children	5 days per week	5 weeks (22 – 25 days) 30 minute sessions	Generalisation probes – administered immediately before the days treatment session on Monday, Wednesday and Friday Retention probes administered 6 weeks post treatment (<i>M</i> = 42, range 35 – 49 days) Number of treatment responders	No significant differences between treatment conditions on any outcome measure Strong relationship between performance at end of treatment and follow up 7/10 treatment responders low density condition 8/10 treatment responders high density condition
7. Proctor-Williams, K., & Fey,	Cohort Analytical (treatment	26 children	SLI group - 7;10 years	Recasts - in the context of a play based activity	Novel verb learning (6 verbs). Syntactically all	Dose Frequency (described by	Planned – Total dose of 30 recasts	Distribution of sessions was not tightly controlled	Duration in weeks not specified. 2	During the intervention - Correct	Children with DLD did not improve their production

M. E. (2007)	words randomly assigned)	children with SLI $n = 13$ (all children assigned verbs in two conditions) younger TD participants $n = 13$	TD group - 5;6 years		verbs were transitive, causative and telic. Phonologically all were single-syllable verbs that marked tense with a vowel shift.	authors as high or low density)	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.	- substantial range in the number of days from the first to the fifth experimental sessions (4 to 44, respectively; $M = 14$ days; $SD = 8.95$).	Training sessions of 31 minutes - 5 experimental sessions - average 31 minutes.	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)	accuracy at higher intervention recast densities
8. Riches, N. G., Tomasello, M., & Conti-Ramsden, G. (2005)	Quasi Experimental	45 children. 23 children with SLI; 22 younger typically developing All children assigned one of 4 verbs in 4 conditions	SLI group mean age 5;6 years TD group mean age 3;5 years	Novel verb modelling using an intransitive frame and a dual morphological frame, alternating between the -ing form and the third person form e.g. dacking, dacks using both was counted as one presentation of the target verb. Dose form was given while playing with a series of objects.	Comprehension and production of four novel verb forms - dack, tam, meek, gorp	Dose (number of exposures) and Dose Frequency (spaced or concentrated)	Four planned doses - Massed 12, 12 exposures on a single day; Massed 18, 18 exposures on a single day; Spaced 12, 12 exposures spread over 4 days (3 per day), and (c) Spaced 18, 18 exposures spread over 4 days (4,5,4,5).	4 days in one week Or 1 day	1 week (between 2 and 10 minutes per sessions)	3 probes; an action probe (what does it do, can you show me), a production probe (what's it doing, can you tell me?) and a comprehension probe (from a choice of three objects - which one was verbing?) were carried out immediately post and one week post intervention.	In relation to comprehension children with SLI benefitted from a greater number of exposures to novel verbs. For production the spacing effect was greater than the effect of the number of exposures i.e. children had better learning after 12 presentations when the exposures were spaced, than after

											18 presentations when the exposures were massed.
9. Schmitt, M. B., Justice, L. M., & Logan, J. A. (2016)	Cohort Analytical	233 children with language impairment.	76 months (ranged from 59 to 96 months)	Not specified as it depended on the target. Business as usual treatment carried out within the public schools system in the USA	One of 9 language focussed targets (grammar, communi-cative functions, discourse, narrative, listening comprehension Abstract language, meta-linguistics, literacy) 3 speech focused (articulation, phonology, fluency, voice) 2 other (behaviour management, transitioning activities and null: no discernible target	Treatment intensity (dose and frequency)	Children received language- focused treatment for about 12 min per session (mean = 11.8, <i>SD</i> = 4.73; range = 0.94–22.69), correspond- ing to about 49% of children’s time in treatment Children received an average cumulative intervention intensity of 1092.3 min (<i>SD</i> = 609.10, range = 66.45–3505.86 min) over an academic year of services.	1.3 sessions per week (range .5 to 4.1) Planned - 40.8 minutes per week Received - an average of 36.11 min/week an average of 46.4 treatment sessions in total across the academic year (<i>SD</i> = 16.56; range = 16–154), corresponding to about one session per week	Estimates of each child’s treatment intensity was based on an average of 28 weeks of the current academic year (range = 7–39 weeks)	The four core subtests of the CELF-4 (con- cepts and following directions, word structure, recalling sentences, and formulating sentences) were administered in the fall and spring of the academic year. The vocabulary subtest from the Woodcock Johnson III Tests of Achievement	children receiving high frequency/low dose, or low frequency/high dose treatment had better outcomes than those receiving high frequency/high dose, high frequency/average dose or low frequency/low dose treatment.
10. Siegmüller, J., Baumann, J., & Höpfe, L. (2017)	Quasi Experimental (Dosage factors studied retro- spectively	30 children with DLD/SLI both terms are used in the paper Once weekly <i>n</i> = 15	Mean age given for 48 children (30 of whom were studied in relation to dosage) 3;11 years (<i>SD</i> 14;77 months)	Intensive modelling of a) verbs and their associated arguments and b) different grammatical subcomponents of the sentence; Questioning to elicit main clause production;	Use of subordinate clause structures	Dose Frequency	Not specified	Once or twice per week	Maximum number of sessions 22. Average number 17. 98. Intervention discontinued before 22 sessions when child showed the	Post testing completed with all children after 16 sessions	Results showed that children who received once weekly treatment needed fewer sessions to achieve therapy goals than the children who received twice weekly sessions.

		Twice weekly $n = 15$		Modelling expansions of the main clause to subordinate clause structures.					ability to expand a given structure to a subordinate clause. Each session an estimated 45 minutes.		Younger children required fewer sessions to achieve goals.
11. Smith-Lock, K. M., Leitaio, S., Lambert, L., Prior, P., Dunn, A., Cronje, S., Newhouse, S., & Nickels, L. (2013)	Quasi Experimental	36 children with SLI (31 in the analyses) Daily treatment $n = 18$ Weekly treatment $n = 13$	Group A 63.61 months Group B 62.08 months	Repeated modelling of grammatical targets, opportunities for the child to produce the targets, feedback to the child, opportunities for child to correct him/herself. Detailed activity plans provided for use in a natural play context	pronouns, possessives, past tense, present tense.	Dose frequency	Not specified	4 times a week for two weeks, once a week for 8 weeks	2 weeks or 8 weeks (1 hour sessions)	Grammar elicitation test (administered 4 times). Each child completed the section of the test relevant to their grammatical target. Gain between Tests 1 and 2 (pre-treatment gain) compared with gains made between Tests 2 and 3 (post treatment gain). Pre-treatment gain compared with gain between test 2 and follow-up	Results showed significant improvement in the spaced treatment group (but not the concentrated group), relative to the same time period prior to treatment. Single-subject analyses indicated a significant treatment effect in 46% of children in the spaced group and 17% in the concentrated group.
12. Storkel, H. L., Voelmle, K., Fierro,	RCT - recruitment not random	27 children with	$M = 5;08$ years Range	children heard: the target word in a book, a definition	Word learning	Dose (using an escalation design 12, 24,	Planned: Depending on treatment	2 to 3 sessions per week	Dependant on treatment intensity	Ability to give word definitions was	Results from the word definition and naming tasks

V., Flake, K., Fleming, K. K., & Romine, R. S. (2017)	but children were randomly assigned to one of four treatment intensity conditions.	language impairment All children assigned words in one of four treatment intensities	5;0 - 6;05	of the target word, a synonym of the target word, the target word used in a supported context sentence.		36, or 48 exposures)	intensity the no. of exposures per session were 3, 4, 6, and 6. For 12 cumulative exposures (target word exposure 3 times in each book and book read 4 times over the course of the intervention); 24 exposures (4x6); 36 exposures (6x6) and 48 exposures (6x8) Received: Based on 20% of sessions - dividing the total number of exposures administered by the intended number of exposures, was 99.92%.		4-5 weeks (10 sessions); 5-8 weeks (15 sessions); and 7-10 weeks (20 sessions) 20 to 30 minutes per session.	measured pre and immediately post treatment. % of children that responded to treatment on the basis of word definitions % of children that responded to treatment on the basis of naming	indicated 36 exposures to be the optimal dose (43% of children responded based on definitions and 86% responded based on naming).
13. Storkel, Komesidou, Pezold, Pitt,, Fleming, & Romine, (2019)	RCT - recruitment not random but children were randomly assigned to treatment arms	34 children with DLD All children exposed to words with dose 6 X frequency 6 protocol In addition half children	<i>M</i> = 5;6 years <i>SD</i> = 0;4	Pre-book reading activity (showing 6 target words in colourful pictures with orthographic label) Reading of book in which target words are highlighted by a box	Word learning of two word sets (60 words in total – 16 nouns, 25 verbs, 19 adjectives) 6 words targeted in a given book	Dose and dose frequency	4, 6 or 9 exposures	9, 6 or 4 book reading sessions Typically, two treatment sessions per week (2 books per session)	12 weeks (4x9 condition) 8 weeks (6x6 condition) 5 weeks (9x4 condition) Average session length was	Primary outcome - Definition task - administered pre, 5/6 days post each treatment session and approx. 21 days post each treatment session	36 exposures supports significant word learning in children with DLD There was a significant drop in children's performance once treatment was withdrawn (60%

		received dose 9 X frequency 4 protocol and half received dose 4 X frequency 9 protocol		<p>Post-book reading activity reviewing 6 target words with different colourful pictures and orthographic label.</p> <p>In each activity children heard the target word, a definition of the target word, a synonym of the target word, the target word used in a supported context sentence.</p>					<p>13 min (4x9 condition) 14 min (6x6 condition) 16 min (9x4 condition)</p>	<p>Secondary outcome – Interim definition and naming task (at 4 points during each treatment, the final test following the last treatment session)</p>	<p>drop 5/6 days post, 70% drop 21 days post)</p> <p>Manipulation of dose x dose frequency did not result in significant differences in word learning outcomes</p> <p>Naming data not reported as they showed the same pattern as the definition data, which were more complete.</p>
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NOTE: The term dose is used differently in the Justice et al. (2017) and Schmitt et al. (2016) studies and is defined as the total amount of time spent addressing any one of nine language-focused targets (it was based on 3 videos but they correlated very highly so was considered representative of each child's dose).