LSHSS

Clinical Focus

Explicit Grammatical Intervention for Developmental Language Disorder: Three Approaches

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Purpose: This article summarizes the shared principles and evidence underpinning methods employed in the three sentence-level (syntactic) grammatical intervention approaches developed by the authors. We discuss associated clinical resources and map a way forward for clinically useful research in this area.
Method: We provide an overview of the principles and perspectives that are common across our three syntactic intervention approaches: MetaTaal (Zwitserlood, 2015; Zwitserlood, Wijnen, et al., 2015), the SHAPE CODING™ system (Ebbels, 2007; Ebbels et al., 2014, 2007), and Complex Sentence Intervention (Balthazar & Scott, 2017, 2018). A description of each approach provides examples and summarizes current evidence supporting effectiveness for children with developmental language disorder ranging in age from 5 to 16 years. We suggest promising directions for future research that will advance our understanding of effective practices and support more widespread adoption of syntactic interventions with school-age children.
Conclusion: In each approach to syntactic intervention, careful and detailed analysis of grammatical knowledge is used to support target selection. Intervention targets are explicitly described and presented systematically using multimodal representations within engaging and functional activities. Treatment stimuli are varied within a target pattern in order to maximize learning. Similar intervention intervals and intensities have been studied and proven clinically feasible and have produced measurable effects. We identify a need for more research evidence to maximize the effectiveness of our grammatical interventions, encompassing languages other than English, as well as practical clinical tools to guide target selection, measurement of outcomes, and decisions about how to tailor interventions to individual needs.

An estimated 7% of the world's children are affected by developmental language disorder (DLD; Bishop et al., 2017; Norbury et al., 2016; Tomblin et al., 1997, 2003). While language difficulties vary by age, language, and functional context, problems with morphology and syntax—the "grammatical" aspects of language—affect a large majority of these children (Fey et al., 2004; Leonard, 2014; Nippold et al., 2009). DLD may be diagnosed in early childhood, but associated language problems persist into early adolescence and even adulthood (Conti-Ramsden, 2008; e.g., Law et al., 2009; Nippold et al., 2009), affecting psychosocial (Clegg et al., 2005) and educational (Conti-Ramsden, 2008) outcomes as well as employment prospects (Conti-Ramsden & Durkin, 2012; Conti-Ramsden et al., 2018; Law et al., 2009). With significant impact on functioning documented across the life span, interventions for children with DLD must address their needs at a variety of ages and support language in academic as well as vocational and social realms.

The amount of evidence supporting effective grammatical intervention procedures varies considerably depending upon language, age, and targets. The vast majority of treatment studies are focused on English-speaking children aged 7 years and under (Cirrin & Gillam, 2008; Ebbels, 2014) and, as a consequence, primarily address English morphological features that are usually acquired in early childhood, with less focus on the developmentally advanced

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syntactic skills needed by older children and adolescents (Nippold, 2010; Scott, 1988; Scott & Balthazar, 2010, 2013; Scott & Koonce, 2014). For the same reason, the approach to grammatical intervention has overwhelmingly been on use of methods that promote implicit learning, which is presumed to be more natural and cognitively appropriate for children whose metalinguistic abilities are limited (Leonard, 2014). There is, however, a growing literature on the efficacy of several approaches to intervention for treating grammatical deficits, particularly sentence-level grammar (syntax) in children with DLD, using explicit intervention procedures (Balthazar & Scott, 2018; Calder et al., 2018; Ebbels, 2014; Finestack, 2018; Finestack & Fey, 2009; Zwitserlood, 2015).

The purpose of this article is to provide a summary of the principles and perspectives that are common across our three syntactic intervention approaches: MetaTaal (Zwitserlood, 2015; Zwitserlood, Wijnen, et al., 2015), the SHAPE CODING system (Ebbels, 2007; Ebbels et al., 2014), and Complex Sentence Intervention (CSI; Balthazar & Scott, 2017, 2018). Each approach is described here along with a summary of the evidence supporting its effectiveness for children with DLD ranging in age from 5 to 16 years. Our aims are to encourage the adoption of evidence-based syntactic interventions and to outline future research that will advance our understanding of effective practices with school-age children with DLD.

Principles and Perspectives Guiding Syntactic Interventions

The MetaTaal, SHAPE CODING, and CSI approaches to syntactic intervention were each developed independently, but they share a common set of assumptions, derived from a common evidence base and theoretical perspective. What sets our sentence-level syntactic interventions apart from other language intervention approaches are three factors: metalinguistic instruction, stimulus organization, and multimodal delivery. While each of our approaches has different methods, all three provide explicit instruction about language structure, organize and present stimuli in a way that promotes implicit learning, and support learning using visual and/or kinesthetic, in addition to auditory, representations of the target structures. The origins of these principles are summarized here in order to guide clinical decision making for speech-language pathologists (SLPs) interested in developing sentence-level intervention plans and to provide background for what we think are areas in need of further study.

Explicit Metalinguistic Instruction

A key component of our syntactic interventions is explicit metalinguistic instruction, defined by verbal description, explanation, and feedback focused on form, the functions of forms, and the manipulation of forms. This kind of instruction encompasses an array of instructional activities, including visual analogies such as LEGO®[1] bricks to represent language structure as in the MetaTaal approach (Zwitserlood, 2015); extensive visual coding of language structures and rules using colors, shapes, and arrows as in the SHAPE CODING system (Ebbels, 2007); and explanation of language structures and how they support specific meanings and functions as in CSI (Balthazar & Scott, 2018).

Metalinguistic teaching is used to fill in gaps in language knowledge by making important syntactic information overt, permanent, and available for examination and discussion (Ebbels et al., 2007) or to bypass or supplement language functions presumed to be impaired (Calder et al., 2018; Ebbels et al., 2014). The overall aim is for the child to internalize the rule and then generalize use of the rule through practice. Although an estimated 69% of U.S. clinicians are using explicit instruction with school-age children (Finestack & Satterlund, 2018), metalinguistic instruction to address linguistic targets has largely been rejected as a primary strategy with young children, whose metacognitive abilities are not well developed. However, a complete rejection of explicit methods with young children may not be justified. Finestack (2018) found that a combined implicit–explicit approach produced a larger effect size than an implicit-only approach, regardless of age, at least with respect to novel morpheme learning. In our syntactic interventions, explicit metalinguistic instruction is viewed as a central feature rather than only a useful adjunct to implicit intervention techniques, with demonstrable treatment effects across a range of ages and targets and, to a lesser extent, multiple languages (e.g., Balthazar & Scott, 2018; Ebbels et al., 2014, 2007; Zwitserlood, 2015; see Table 1).

Findings that explicit teaching of grammatical rules to school-age children with DLD yields positive results are consistent with the procedural deficit hypothesis, which stresses the relatively better skills in children with DLD of visuospatial memory and explicit learning in the context of relatively poorer implicit learning (Lum et al., 2012; Ullman & Pierpont, 2005). The procedural deficit hypothesis claims that children with DLD are impaired at grammatical rule learning because of a deficit in their procedural memory system. To compensate, they rely on their declarative memory system. Accordingly, children with DLD may be better able to learn grammatical rules when they are taught explicitly (in declarative memory) and learning is enhanced by visual (or multimodal) support. A further argument that is less often discussed in studies on metalinguistic intervention is that, although children with DLD appear to have poorer metalinguistic skills than typically developing children (Kamhi & Koenig, 1985; Menyuk et al., 1993), these skills do exist and can in fact be employed successfully to remediate grammatical problems in a metalinguistic approach (e.g., Finestack, 2018). It is possible that the metalinguistic intervention also enhances metalinguistic skills in children with DLD and serves as a mediating

[1]LEGO® is a trademark of the LEGO Group of companies which does not sponsor, authorize, or endorse this study.

Table 1. Studies targeting grammar in children and adolescents with language disorders (Ebbels, 2014).

Source and design	Age (years;months) and number of participants	Language target	Intervention	Outcomes and magnitude of effects[a]
Ebbels et al. (2007) RCT	11;0–16;1 *N* = 27	Production of verb argument structure	SHAPE CODING system or a semantic intervention Direct 1:1, 1 × 30 min per week for 9 weeks	SHAPE CODING: Both intervention groups improved significantly more than controls on verb argument structure. (for the SHAPE CODING group vs. controls: *d* = 1.3, large effect size). Maintained for 3 months. Generalized to control verbs.
Ebbels et al. (2014) RCT	11;3–16;1 *N* = 14	Comprehension of coordinating conjunctions	SHAPE CODING system Direct 1:1, 1 × 30 min per week for 8 weeks	The SHAPE CODING group showed significantly more progress than waiting controls on targeted conjunctions (*d* = 1.6, large effect size). Waiting controls also made significant progress when they too received intervention (*d* = 2.1, large effect size). Generalized to TROG-2 assessment, (*d* = 1.4, large effect size), but not to passives. Maintained for 4 months.
Ebbels & van der Lely (2001) Multiple baseline	11–14 years *N* = 4	Comprehension and production of *wh*-questions and passive formation	SHAPE CODING system Direct 1:1, 2 × 30 min per week (10 weeks for passives, 20 weeks for *wh*-questions)	Three of four participants showed significant progress with comprehension and expression of passives. Two participants focused on comprehension of *wh*-questions and made significant progress. All four focussed on production of *wh*-questions and made significant progress with subject questions. Two of four made significant progress with object questions. After 30 weeks, progress maintained for 2/3 on passive comprehension and expression, 1/4 for production of subject *wh*-questions, and 0/4 for production of object questions.
Ebbels (2007) Multiple baseline	11;8–12;9 *N* = 3	Comprehension of dative and comparative *wh*-questions	SHAPE CODING system Direct 1:1, 2 × 30 min per week for 10 weeks	Two of three children showed significant progress with dative; 2/2 showed significant progress with comparative *wh*-questions.
Kulkarni et al. (2014) Multiple baseline	8;11 and 8;10 *N* = 2	Use of past tense morphology	SHAPE CODING system Phase 1: 1 × 30 min per week with SLT for 10 weeks, plus 3.5 hr with TA for Participant A and 0.5 hr with TA for Participant B. Phase 2: SLT carried out four sessions in class, met with parents, and carried out session at participants' homes.	Participant A: stable baseline, then significant progress on sentence completion for treated and untreated verbs after Phase 1, and progress on conversation task only after Phase 2. No change in control structure. Participant B: stable baseline, then significant progress with conversation after Phase 1, and progress in sentence completion task only significant after Phase 2. No change in control structure. Progress maintained for 6 weeks. For Participant B, generalization occurred to conversation during Phase 1. Participant A needed generalization therapy (Phase 2) for progress to generalize to conversation.

(*table continues*)

Table 1. *(Continued).*

Source and design	Age (years;months) and number of participants	Language target	Intervention	Outcomes and magnitude of effects[a]
Calder et al. (2018) Multiple baseline	6;2, 6;6, and 7;0 *N* = 3	Use of past tense morphology	SHAPE CODING system plus systematic cueing hierarchy Direct 1:1 with SLT, 2 × 25 min for 5 weeks	2/3 made significant gains in targeted expressive morphosyntax (*–ed*) After 5 weeks, some decreased for 1/3 and further increased for 1/3. Generalized to TROG (2/3) and TEGI (3/3)
Calder et al. (2020) Multiple baseline	5;10–6;8 *N* = 9	Use of past tense morphology	SHAPE CODING system plus systematic cueing hierarchy Direct 1:1 with SLT, 2 × 20–30 min per week for 10 weeks, 50 trials per session (1,000 in total)	Most children showed significant improvement on trained verbs within (8/9, *d* = 0.9, large effect size) and between (7/9, *d* = 0.9, large effect size) sessions and untrained verbs (7/9, *d* = 0.8, large effect size). Progress maintained for 5 weeks. Generalized to grammaticality judgment (*d* = 0.26, small effect size) and standardized measures of expressive grammar, SPELT-3 (8/9), but not receptive grammar (1/9). Gains on control measures not significant when participants combined: 3s (1/9, *d* = –0.05, no effect); 's (2/9, *d* = 0.1, no effect).
Tobin & Ebbels (2019) Single-baseline design	10–14 years with complex needs (including six with Down syndrome) *N* = 11	Singular vs. plural auxiliary or copula	SHAPE CODING system Direct 1:2 or 1:3, 2 × 20 min per week for 4 weeks	Significantly more progress with intervention than during baseline (*d* = 0.92, large effect size). Generalized from auxiliary to copula and vice versa.
Ebbels (2007) Group study comparing pre- and posttest scores	11–13 years *N* = 9	Use of past tense morphology in writing	SHAPE CODING system Direct group for 1:9, then 1:2 for two children, 1 hr per week for 16 weeks + approximately 4 hr for two children	As a group, postintervention scores did not differ from preintervention scores, despite a large effect size (*d* = 1.7). Six of nine children improved; two improved only after an additional paired therapy. Generalized to spontaneous written work in class.

(*table continues*)

Table 1. *(Continued).*

Source and design	Age (years;months) and number of participants	Language target	Intervention	Outcomes and magnitude of effects[a]
Balthazar & Scott (2018) Multiple-baseline design	10;10–14;11 *N* = 30	Production of complex sentences (adverbial, object complement, and relative clauses)	Complex Sentence Intervention Direct 1:1, 9 or 18 × 40–60 min once or twice a week for 9 weeks	Written sentence combining pre–post improved significantly (η^2 = .816; medium effect size); effects differed for each sentence, with significant gains on average for adverbial (SMD_p = .91; large effect size) and relative (SMD_p = 1.00; large effect size) clauses. Twenty-four participants (80%) demonstrated a medium or large effect size on at least one of the sentence types. Seven (23%) of the participants achieved a medium or large effect size on two sentence types; eight participants (27%) achieved it on all three. Similar gains in both the low- and high-dosage groups. No generalization to written narratives.
Zwitserlood, Wijnen, et al. (2015) Single-baseline design	9;3–12;8 *N* = 12	Comprehension and production of relative clauses	MetaTaal Direct 1:1, 10 × 30 min twice a week for 5 weeks	Production of relative clauses via (written) sentence combining improved significantly with intervention (*r* ranged between −.53 and −.60; medium effect size). Elicited production (without written prompts) and comprehension of relative clauses did not improve. Maintained for 3 months.
Zwitserlood (2015) Single-baseline design	9;7–15;11 *N* = 18	Comprehension and production of relative clauses	MetaTaal Direct 1:1, 10 × 30 min twice a week for 5 weeks	Production of relative clauses via (written) sentence combining improved significantly with intervention (*r* ranged between .40 and .50; medium size effects). Elicited production (without written prompts) and comprehension of relative clauses did not improve. Maintained for 3 months.

Note. RCT = randomized controlled trial; TROG-2 = Test for Reception of Grammar (Bishop, 2003); SLT = speech-language therapist; TA = teacher aide; TEGI = Rice/Wexler Test of Early Grammatical Impairment (Rice & Wexler, 2001); SPELT = Structured Photographic Expressive Language Test 3 (Dawson et al., 2003).

[a]Effect sizes in each of these studies were reported for different language targets and outcome measures and using a number of different effect size metrics. While these values are not directly comparable across studies, for illustrative purposes, we have provided effect size values and magnitude of effects where possible. Please refer to the original study reports for technical information regarding effect size.

factor in their language gains. The idea that metalinguistic ability and language knowledge are interrelated in this way is supported by a recent cognitive–linguistic model demonstrating that metacognitive and linguistic abilities have reciprocal mediating effects on performance (R. B. Gillam et al., 2019; Montgomery et al., 2018). All three of our approaches thus use both contextual/inductive types of learning tasks and metalinguistic, explicit instruction designed specifically to prop up areas of cognitive–linguistic weakness (such as long-term memory for language knowledge) with areas that can be influenced therapeutically (viz., language experience).

Stimulus Organization: Priming, Density, and Variability

While we consider explicit instruction and deductive learning to be key parts of syntactic intervention, we also view them as a bootstrap, not a replacement, for learning that occurs implicitly. For this reason, our intervention programs systematically organize treatment stimuli in order to maximize inductive learning. Priming refers to the presentation of target forms (in higher density than found in conversation), for increasing the likelihood that the target forms will be subsequently produced (Leonard, 2011). There have been no experimental studies that investigate structural priming in treatment of syntactic structures per se, but as Leonard (2011) concluded, what is known about priming should be considered when designing methods for fostering learning of sentence structures. This reasoning supports modeling and imitation activities that provide a higher density of the intended sentence types at the beginning of a treatment session.

While priming appears to be theoretically and practically important to prepare a child for learning a syntactic pattern, increasing the density of models alone may not help (e.g., Proctor-Williams & Fey, 2007). It has been posited that the type of task involved in the intervention can interact with frequency of exposure to produce different effects (e.g., Kan & Windsor, 2010). Priming provided in a context in which the learner is exposed to both the new linguistic pattern and what it means may optimize learning (e.g., McGregor et al., 2007). Most related treatment studies have focused on word learning, not syntax, but the findings highlight the potential problem with assuming that "more is better."

Taken together, the current evidence makes it reasonable to anticipate that priming, combined with active attempts to manipulate and use forms, particularly in meaningful contexts, would be of benefit in teaching syntactic forms, by increasing the density and frequency of exposures to a level that students with DLD are likely to need in order to learn. Finally, research on statistical learning principles (cf. Plante & Gómez, 2018) indicates that we can expect a positive effect of stimulus variability on language learning (e.g., Plante et al., 2014). Individuals with DLD may be better able to induce an underlying syntactic rule if we not only make the pattern frequent and salient enough but also use many different stimulus sentences, rather than focus on mastering a limited set of stimulus sentences. All three of the syntactic interventions presented here facilitate rule induction by using many different exemplars of target forms, with varying vocabulary, including syntactic, semantic, and pragmatic variations found in different communicative contexts (i.e., conversation, narration, exposition).

Multimodal Representations

Language intervention activities can involve a number of "modalities" for how clinicians present models and stimulus items and how children provide responses. Our approaches are designed to be "multimodal," providing combinations of auditory (aural/oral), visual (reading/writing, shapes, colors), and kinesthetic (touching/moving) interactions with the language material. The rationale for this multimodal approach is to provide an optimal learning environment (Shams & Seitz, 2008) and to raise the level of active participation, enjoyment, and motivation through sensorimotor engagement (Sankey et al., 2010). Use of multiple modalities of presentation and response can help circumvent any limited processing capabilities of the individual channels (Birsh, 2005; Clark & Paivio, 1991). Each of our approaches provides instruction in varied communicative and representational modalities.

Our syntactic interventions have been delivered using stable visual representations found in written language, but also with visual/kinesthetic analogies such as LEGO bricks. Visual representations should gradually be withdrawn to encourage internalization of the rule. Varied tasks within a session (e.g., some paper based, some at the computer, some with pictures, some constructive, some discourse level) are included in order to help skills generalize across different communicative tasks and, importantly, to engage a student's attention, so that they can sustain focus on metalinguistic and linguistic information.

Practical Considerations

Specifying Syntactic Targets

Careful and detailed analysis of a child's grammatical knowledge is critical in order to support target selection. Because the syntactic structures must be explicitly described and presented systematically, the clinician must have a good understanding of grammar to identify which specific areas the child is struggling to understand or produce and which of these is most functional and important in the child's current circumstances. While individuals with DLD may never reach the same level of proficiency as their peers when it comes to morphosyntactic language features (Rice et al., 2009), most will eventually "master" the main syntactic and grammatical structures of the language, at least to the extent that they do not present obvious problems in conversation. However, the later developing types of complex sentences—namely, relative clauses—often remain poorly understood and infrequently used (particularly in writing) by older children with DLD

(R. B. Gillam & Johnston, 1992; Marinellie, 2004; Scott & Windsor, 2000). However, even those capable of producing later developing syntactic structures remain much less likely to do so with the same frequency and level of sophistication typical of peers without DLD (Nippold et al., 2009), particularly when faced with additional challenges such as unfamiliar content and tasks that are more complex due to interactions with other areas of weakness (e.g., reading fluency or handwriting; cf. Scott & Balthazar, 2010; Scott & Koonce, 2014). The goal in this case is to extend performance into those more troublesome contexts. None of our three approaches takes a position as to sequencing targets according to a developmental order. Any recommended sequencing of targets will be presented in the description of each approach.

Intervention Schedule

For older children whose language difficulties have persisted into middle and high school, the issue of how much speech and language intervention should be delivered is an important one. Generally speaking, school clinicians base their dosage decisions on local standards, which are designed to keep balance between caseload size, severity, and student availability. Syntactic treatment studies with children like those in the target population have utilized once- or twice-weekly sessions of 20–60 min in length, over periods of time ranging from 5 weeks to 12 months, and have been successfully delivered within that schedule, with varying degrees of effectiveness depending on the target structures and outcome measures. The gains demonstrated in studies using treatment schedules in this range are encouraging, at least as a starting point. All three of our approaches have been designed with practical feasibility of service delivery in mind; consequently, our evidence for effectiveness is grounded in schedules that could be adopted within most treatment settings. Systematic investigation of dosage as it relates to syntactic intervention in school-age children with DLD has not yet been undertaken, but the evidence base, to date, provides a starting point for this type of work. Related factors such as distribution of learning episodes over time may be important and should be explored relative to syntactic interventions (cf. Ambridge et al., 2006; Riches et al., 2005). A comprehensive summary of evidence is available in Ebbels (2014), and we have adapted and expanded the table she provided to include all of our current studies. Table 1 provides effect sizes (when available) and magnitude of effects. Future studies using the same approaches, populations, and outcome measures could compare different dosage variations against the effect sizes described in the evidence base for our three approaches.

Approaches to Syntactic Intervention

The evidence base surrounding interventions designed specifically to teach sentence-level structures has been growing. Here, we will focus on the three approaches that have been adopted in the majority of the research with school-age children to date: the SHAPE CODING system (Ebbels, 2007; Ebbels et al., 2014, 2007), CSI (Balthazar & Scott, 2017, 2018), and MetaTaal (Zwitserlood, 2015; Zwitserlood, Wijnen, et al., 2015). None of the three approaches is prescriptive in nature, but rather, they each provide a tool to help professionals make grammatical rules visual and explicit when providing grammatical intervention.

The SHAPE CODING System

The SHAPE CODING system aims to help children with language disorders learn the grammar of English (although it is now being adapted for other languages), so they can produce and understand longer and more complex sentences and make fewer grammatical errors in their spoken and written language. The SHAPE CODING system was developed by Susan Ebbels (a co-author of this article) at Moor House School & College, a specialist center in the United Kingdom for children with language disorders aged between 7 and 19 years. Within this context, there was a need for a system to support older children with language disorders to learn more complex syntactic structures than those usually targeted in younger children. The SHAPE CODING system combined elements from color coding systems used with younger children (the Colour Pattern Scheme [Lea, 1970] and Colourful Semantics [Bryan, 1997]) and extended them, particularly by using shapes and arrows in addition to colors, to allow coding of much more complex syntactic structures than was possible with those systems.

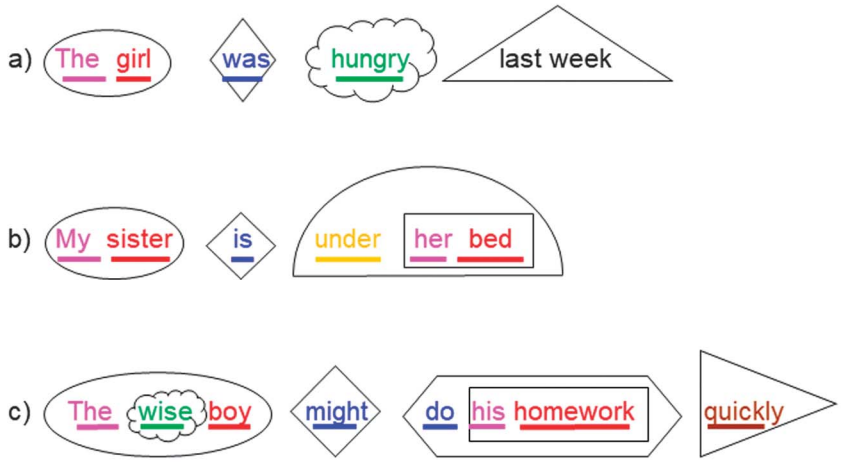
Components of the SHAPE CODING System

The SHAPE CODING system has four main components: (a) shapes (for phrases, such as noun phrase, verb phrase, and adjective phrase), which are linked with questions such as “who,” “what doing,” “what like,” and “how feel”; (b) colors (for parts of speech); (c) single/double lines (for marking singular and plural); and (4) arrows (for verb tenses).

Shapes. Each shape groups words into phrases that answer a question such as “who,” “where,” and “what doing” (see Figure 1 for examples and Table 2 for a list of the shapes, their related question, and their syntactic role).

Colors. Colors are used for parts of speech and are associated with particular shapes (see Table 3). In some shapes, a particular color word is required (e.g., a red word/noun in an oval/noun phrase). However, additional words can also appear; indeed, this is how sentence complexity is built up. Colors may not always be used as this can be confusing, especially when lots of words are included; in this case, the words may just be written in black. The sentences in Figure 1 are simple sentences, but the same patterns could also be used for complex sentences with each shape containing many words. Figure 2 shows the same basic patterns but applied to complex sentences. Here, the

Figure 1. Simple sentences coded with the SHAPE CODING system.



colors are not used, or the internal structure, as the aim is to show the overall meaning of the sentence. However, colors and additional internal shapes could be included, if desired.

Lines for singular and plural. Noun–verb agreement is shown in the SHAPE CODING system by using double lines under plural nouns and verbs and single lines under singular nouns and verbs (see Figure 3). This helps avoid errors such as "the boys is running," as the noun and verb must match in terms of single or double lines. A double red line in the oval noun phrase requires a double blue line in the diamond auxiliary or copula (which goes with "are" or "were"). If there are two entities in the oval (and hence two red lines in total, e.g., one under "boy" and one under "dog"), a double line is required in the diamond. This can help prevent errors such as "the boy and his dog is running" as the single line under "is" does not match the two red lines in the oval.

Arrows. Verb morphology is indicated by underlining verbs (in blue) and using arrows (see Figure 4). Tensed verbs have vertical arrows, with a vertical arrow in the middle of the line for present tense and at the left-hand end for past tense. The progressive participle has a zigzag under "–ing" to represent the continuous aspect. Children are taught that every sentence must have "a down arrow" (i.e., a tensed verb) and this has to match the time arrows on any "when" triangle.

Practicalities of Introducing and Using the SHAPE CODING System

The SHAPE CODING system is a flexible tool that can be used to teach whichever aspect of morphosyntax is the current target for the child. Thus, the first step is for the SLP to decide which area to focus on, and this will depend on which specific areas the child is struggling to understand or produce and which of these is most functional and important in the child's current circumstances, for example, which will help the child communicate or access and participate in lessons better. These decisions are separate from decisions about which methods to use. Once the SLP has chosen a target, the SHAPE CODING system may help them show the child how the rules for that structure work. It is likely that only some aspects of the SHAPE CODING system will be required, depending on which structure is targeted, and only those aspects need to be taught. Others can be added in later as other targets are introduced.

The SHAPE CODING system is introduced to children using complete sentences, usually using structures they

Table 2. Shapes of the SHAPE CODING system.

Shape	Related question(s)	Syntactic role	Color word required
Oval	Who/what?	External argument noun phrase (subject in active sentences)	Red (often also pink)
Rectangle	Who/what?	Internal argument noun phrase (belongs inside other shapes)	Red (often also pink)
Cloud	What like/how feel?	Adjective phrase	Green
Semicircle	Where?	Usually prepositional phrase (preposition + internal argument NP)	Often yellow
Hexagon	What doing?	Verb phrase	Blue
Diamond		Auxiliary, copula, modal verbs	Blue
Triangle	When?		
Flag	How?		

Note. NP = noun phrase.

Table 3. Colors of the SHAPE CODING system.

Color	Part of speech	Examples	Related shape
Red	Nouns and pronouns	dog, chair, he, him	Ovals and rectangles
Pink	Determiners and possessive pronouns	the, a, his	Often required with "red words" in ovals and rectangles
Blue	Verbs	sleep, snore	Hexagons and diamonds
Green	Adjectives	small, sad	Clouds
Yellow	Prepositions	on, under, beside	Semicircles
Brown	Adverbs	slowly, fast	Flags
Purple	Coordinating conjunctions	and, but, or	
Orange	Subordinating conjunctions	when, if, because	Often triangles

can already produce and understand. The starting point will depend on what structures are targeted, but given that many grammatical targets for children with DLD involve verbs, the most common starting point is probably a simple subject–verb sentence, for example, "the man is laughing." This would normally be introduced in the present progressive (even if the child usually omits the auxiliary, this would still be shown but would not be a focus in the initial stages). The initial focus is for the child to understand that the person or thing doing the action ("the man") goes in the oval and answers the question "who/what?", while the action ("laughing") goes in the hexagon and answers the question "what doing?". This can be done by turning shapes around that have the question on the back and the phrase on the front, so that they see the direct connection between the question and the answer. Laminated shapes work well for this, and the SHAPE CODING app also aims to recreate this by flipping the shape following a long hold to reveal the question. Omissions of determiners "the," possessive pronouns "my," or progressive endings "–ing" are less important at this stage and can be a focus of later intervention.

A key early step when using the SHAPE CODING system is for the children to understand the link between a question (e.g., "who") and its answer (e.g., "the man," "the dog," or "Sam"). It is also important that the children do not think that each shape contains a single word, so a next step may be to introduce subject–verb–object sentences (e.g., "the dog is chewing a bone") and show that the answer to the question "what is the dog doing" is "chewing a bone," thus more than one word. The rectangle may or may not be put around "a bone" depending on whether the SLP wants to focus on this (e.g., this may be desirable if the focus will be on verb argument structure or increasing sentence length but may not be necessary if the focus will be on tense or agreement).

When teaching the child a new grammatical structure or rule, the following sequence may be used.

1. The SLP introduces the target structure and grammatical rule using the SHAPE CODING system and demonstrates its meaning (often using small figures that can be placed on the relevant shapes and also act out the meaning).
2. Templates for that structure may be created using the shapes, colors, arrows, and/or lines as appropriate to the target. These may be on paper or may be separate laminated shapes that can be written on or

Figure 2. Complex sentences coded with the SHAPE CODING system.

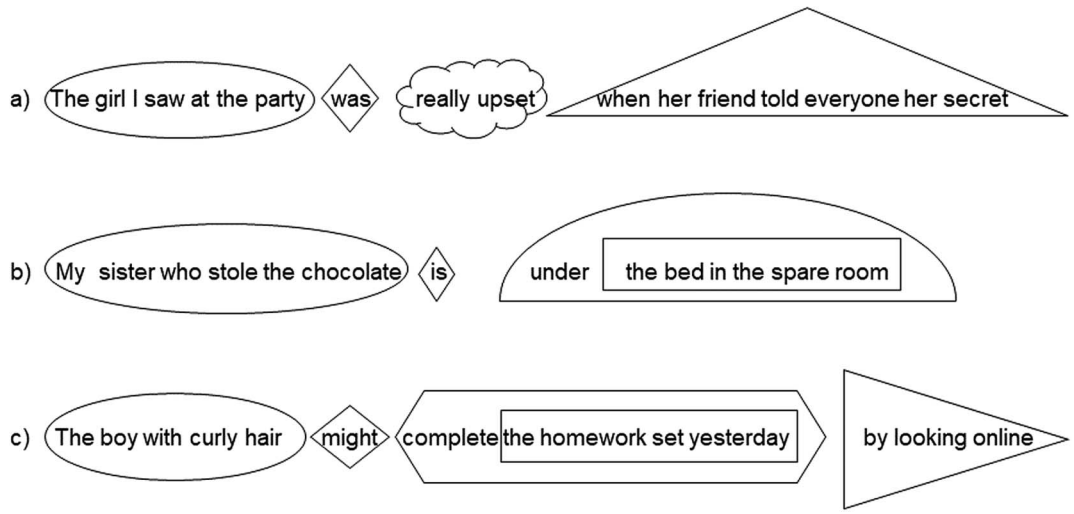
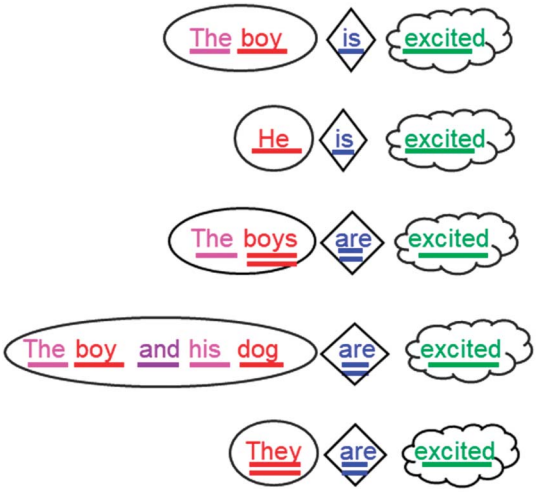


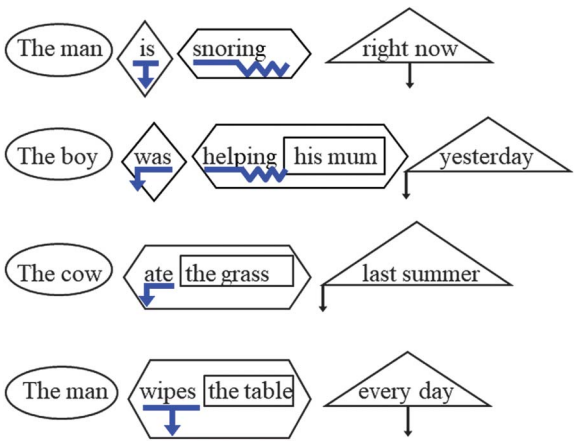
Figure 3. Noun–verb agreement using the SHAPE CODING system.



could be on a computer screen or on the SHAPE CODING app.

3. The adult and child take turns to create sentences that match the shape template, either orally, or written, or drawn on laminated shapes, or on the app. Suitable words that can go in different shapes could be discussed in advance if these are not already available (as they are in the app), or the adult/child could think of words on the spot. This is often preferable if within the child's capability as it is more creative and shows the flexibility and power of language, leading to sentences that are of interest or amusing to the child, which in turn leads to increased motivation. While the app already has built-in suggested words for each shape, it is also possible to add custom words of interest to the child.

Figure 4. Coding of verb tenses and time using the SHAPE CODING system.



4. The adult/child acts out the other's sentence using small figures that can be placed on the oval and rectangle shapes to help work out which role they play in the sentence (this is particularly important for children whose targets involve comprehension, but for those with expressive targets, this is also helpful to show how their grammatical errors can affect meaning).
5. Any errors that cause a change in meaning, or which result in a pattern that does not match the sentence template, are discussed and corrected.
6. The shape templates are removed, and the sentence structure is produced and acted out if applicable. The aim of this is for the child to internalize the structures. Then, the shape templates are brought back into view, and the accuracies of both production and comprehension are checked with the template.
7. At the generalization stage, the adult may set up situations where the targeted structures are likely to be used or where instructions including the target need to be followed and then praise any use or correct comprehension of the target, or correct errors by referring to the rules (e.g., "oops, you missed a diamond then" or "the dog was in the oval. So the dog is doing the action, not the cat"). The shape templates could be brought back if mentioning the rules does not lead to correct production or comprehension. A cueing hierarchy could also be used (see Calder et al., 2018, 2020).

Evidence Base for the SHAPE CODING System

The effectiveness of the SHAPE CODING system has been investigated in a small but growing number of studies, which are summarized in Table 1. In contrast to most interventions, these studies include some that focus on comprehension. The intervention studies include two small-scale randomized controlled trials (RCTs; Ebbels et al., 2014, 2007). In both of these, those children receiving intervention using the SHAPE CODING system improved significantly more than controls who received intervention on other areas of language. The first RCT involved 27 participants with DLD aged 11–16 years (Ebbels et al., 2007), investigated production of verb argument structure, and compared 4.5 hr of intervention (30 min weekly for 9 weeks) using the SHAPE CODING system (called "semantic–syntactic therapy" in the study), with intervention focusing on verb semantic representations. The progress of participants in these groups was compared with that of participants receiving a control intervention of equal intensity and length on an unrelated area. Both methods were based on detailed hypotheses regarding the underlying reasons for the participants' difficulties with verb argument structure, and both groups made significant progress in verb argument structure, unlike the control group. Progress in the intervention groups also generalized to nontaught verbs and was maintained 3 months after intervention ceased.

The second RCT (Ebbels et al., 2014) involved 14 participants with DLD also aged 11–16 years and focused on comprehension of coordinating conjunctions ("but not," "neither nor," "not only but also") for 30 min weekly for 8 weeks (4 hr). The results showed those in the intervention group improved their comprehension of the targeted conjunctions significantly more than the waiting controls. The waiting controls had received equal amounts of intervention on other areas of language, but when they too received intervention using the SHAPE CODING system focused on the target area, they then also made progress. Progress also led to increased scores on the Test of Reception of Grammar (Bishop, 2003). Analyses of child-related factors (including nonverbal and visual processing abilities) revealed no significant predictors of response to intervention.

Other smaller, less robust studies have also been carried out into the effectiveness of the SHAPE CODING system. Ebbels and van der Lely (2001) used a multiple baseline design and aimed to improve expression and comprehension of passives and *wh*-questions in four adolescents with DLD (aged 11–14 years). Three of the four participants showed significant progress in both their comprehension and production of passives after 10 hr of intervention. Intervention on *wh*-questions lasted for 20 hr. Two participants had difficulties comprehending *wh*-questions preintervention, and both showed significant progress in this area. All four participants showed short-term progress with the production of *wh*-questions, but only one participant maintained this at a significant level by follow-up. The three participants who responded best participated in a follow-up study (Ebbels, 2007) targeting comprehension of the dative construction (e.g., "the boy is giving the girl the rabbit") and comparative *wh*-questions (e.g., "what is bigger than a cat?" vs. "what is a cat bigger than?"). All three received intervention on datives, but only two received intervention for *wh*-comparatives due to a change of SLP. Two of the three participants showed significant progress in their comprehension of dative constructions. The third was hypothesized to have additional short-term memory difficulties, which made progress on this area more difficult, due to the need to remember the order of three key nouns. However, this participant made significant progress in comprehension of comparative *wh*-questions, as did the other participant who was taught this structure.

The majority of the studies of the SHAPE CODING system have been with secondary-age children. However, recent studies have investigated its effectiveness with younger children with DLD for improving the use of the past tense (Calder et al., 2018, 2020; Kulkarni et al., 2014). Kulkarni et al. (2014) carried out a multiple baseline design with two children aged 8;11 and 9;4 (years;months) and found significant gains after 5–8 hr of intervention. The studies by Calder et al. (2018, 2020) involved participants aged 5;10–7;0 and combined the SHAPE CODING system with a systematic cueing hierarchy resulting in significant progress in the use of the past tense after 5 hr (2018) or 10 hr (2020) of intervention for the majority of the participants.

CSI

CSI (Balthazar & Scott, 2017, 2018) was developed in order to help children with DLD aged 10 years and up meet the syntactic demands of the academic environment. The aim of CSI is increased use and variety of complex sentences, focusing on complexity created through subordinate clauses. The CSI protocol teaches the three types of subordinate clauses that account for the large majority of complex sentences found in texts and in the spoken and written output of mature language users: adverbial clauses, object complement clauses (clauses in object position), and relative clauses (Loban, 1976; Perera, 1984; Scott, 1988). Each type of subordinate clause is taught in two-clause sentences in order to maximize focus on the relationship between the main and subordinate clauses. Each session is organized to provide explicit descriptions and practice in identifying and manipulating clauses. Contextualized practice using material from curriculum-based texts and common academic tasks is also included in order to expand and deepen conceptual foundations that contribute to functional use and comprehension.

Adverbial Clauses

In sentences with adverbial clauses, a subordinate clause is joined to a main clause, usually with a conjunction such as "although," "while," "whereas," "because," "if," "unless," and so forth. Adverbial conjunction words encode logical relationships. These types of clauses expand on the verb in the main clause by adding information about relationships including time, cause, manner, or place. The default position of an adverbial clause is after the main clause (right-branching, e.g., "Student grades will be posted tomorrow even though Professor Jones is on medical leave"); however, adverbial clauses can be placed before the main clause in order to emphasize it or to provide transitions between sentences (left-branching, e.g., "Even though Professor Jones is on medical leave, student grades will be posted tomorrow"). Left-branching adverbial clauses, also referred to as "fronted adverbials," are later developing and much more prominent in literate than conversational language.

The key features to explain are that (a) the adverbial clause will tell more about the main clause, such as the time, cause, place, or manner of something that happened; (b) the adverbial clause will usually start with an adverbial conjunction; and (c) adverbial clauses often come after the main clause, but they can come before it, too. It is a good idea to provide a list of the adverbial conjunction words to use during instructional activities.

Object Complement Clauses

A second type of subordination is an object complement clause, in which the object of the main clause verb is a whole clause rather than just a noun phrase. These types of clauses often begin with "that," but the word is optional, and if taken away, the sentence is still grammatical. Other words that begin object complement clauses

include question words such as "what," "when," "who," and "where." Note that not all verbs with an argument structure including direct objects can "take" an object complement and the ones that do tend to be verbs referring to state of being or communicative acts (stative and reportative verbs, such as "be," "let," "tell," "say," and "exclaim") or that code mental states (cognitive state verbs, metalinguistic verbs) such as "think," "know," "conclude," "decide," and "predict." This group of verbs is important in academic language because they allow writers to address processes, ideas, and opinions as objects.

A list of verbs that take object complements, drawn from grade-level curriculum materials, can be a helpful visual reminder during instructional activities. Since object complements take many forms, it may be also be helpful to show the different patterns (see Balthazar & Scott, 2017). An explanation could include telling the student that (a) some verbs help us talk about feelings, thoughts, senses, and mental activities; (b) these verbs can have object complement clauses after them; (c) the object complement tells "what"; and (d) there is more than one way to make an object complement clause.

Relative Clauses

Relative clauses, the third type of subordinate clause, follow a noun and provide additional information about that noun. Typically, they begin with a relative pronoun ("that," "who," "whose," "which"), as in (1), but "that" can be optional, and sometimes the clause is further reduced, as in (2).

(1) Forty-five milligrams is the maximum daily intake *that is recommended by the Food and Drug Administration*.
(2) Forty-five milligrams is the maximum daily intake ~~*that is*~~ *recommended by the Food and Drug Administration*.

Relative clauses can be classified into four types, depending on their position in the main clause and whether the relative pronoun, which is always the head of the relative clause, is the semantic subject or object of the subordinate clause. When a relative clause modifies a subject noun, it interrupts the subject and verb, as in (3). These are often called "center-embedded relatives," and they are among the later developing and more challenging types of relative clauses for children with DLD, especially if they have poor auditory memory.

(3) Almost all of the money *that search engines make* is based on the keywords you type in.

Relative clauses also vary in another important way, namely, whether the relative pronoun replaces the subject of the relative clause, as in (1), or the object, as in (3). Object relative clauses tend to be more difficult, because the relative pronoun occurs in subject position of the clause but actually replaces a noun in the object position that is no longer visible.

The key features to explain are (a) that a relative clause tells more about a noun, (b) that it always follows the noun that it tells about, (c) that it can be after the subject noun or an object noun, and (d) that it usually starts with a relative pronoun. It is helpful to provide a list of the relative pronouns for the student to use during instructional activities.

Session Components

The features of the target subordinate clause are first explained verbally with several examples shown in writing. As the verbal explanation proceeds, the clinician marks the examples to indicate the features visually (see Figure 5). After explanation, there are several additional examples for repetition and then a short reading with the target sentence types highlighted. There are then several practice activities, including sentence identification, sentence deconstruction, and sentence combining, during which correct responses are scaffolded with gradually diminishing levels of clinician supports such as cues and models. A contextualized task completes the session, either sentence generation, preference production, or cloze production. These last activities focus on the meaning and function of the subordinate clauses, by either encoding ideas using the target sentence structure, contrasting meanings of alternate sentences, or recalling and reproducing example sentences from a longer text.

Sentence repetition. In sentence repetition tasks, several sentences with the target structure are presented for repetition. The student listens and then repeats. Usually, three to five examples of the target pattern, drawn from different topics and contexts, are developed for this purpose.

Reading aloud. In a read-aloud activity, a short passage (between approximately 50 and 100 words) that contains several exemplars of the target type of sentence can be presented for the student and clinician to read aloud together. The objective of this choral reading is to encourage fluent reading by providing adult support. This allows for grade-level subject matter to be included without the student getting bogged down by her independent reading level. The clinician reads expressively and at a normal to slow-normal rate, so that the student can keep up. If the student misses a word, it is usually self-corrected along the way, and the clinician can pause to allow self-correction. The target complex sentences should be reviewed after reading, to briefly discuss what each added to the sentence or how the subordinate clause related to the main clause. This is an opportunity to reinforce the relationship between the type of complex sentence and how it is used to convey particular meanings in connected discourse. The aim is to illustrate and prime the student with examples, not to achieve perfect and complete comprehension.

Sentence identification. The aim of the identification activity is to teach the child about the key sentence features associated with the target subordinate clause. In sentence identification, complex sentences can be presented on paper or on the computer, and the student highlights the target subordinate clause (see Figure 6).

Sentence deconstruction. The aim of the deconstruction activity is to assist the student in transforming the subordinate clause into its base form. Sentence deconstruction

Figure 5. Example of an explanation of visual codes for a relative clause, as presented in electronic format on a computer screen.

Lidia shared her lunch with the girl **who** didn't have one.

SLP script: First, we underline the verbs to see if we have a complex sentence. This sentence has two different verbs, "shared" and "didn't have," and it is complex. It has a relative clause in it. The green words are the relative clause, and the green word that is in bold is the relative pronoun. This relative clause, "who didn't have one," describes the girl. We've circled "girl" to show which noun the relative clause tells about.

begins the same way as sentence identification, but the main and subordinate clauses are pulled apart. These sentences can be presented on paper or on a word processing program or app (see Figure 7). Students either write out the main clause and the subordinate clause on paper or highlight and move these clauses into the appropriate slots on a computer or tablet device. Deconstruction is particularly helpful for illustrating how relative clauses, which involve both pronominal replacement and often a change in word order, are constructed.

Sentence combining. Sentence combining also illustrates the relationship and transformation involved in creating a complex sentence. Two clauses are presented in a form that facilitates a student's ability to easily rearrange words to create their responses, such as movable strips of paper or electronic media as with sentence deconstruction. The clinician helps the student start combining by building the ideas behind the sentence and gradually guiding the student into the desired sentence form. Grammatical, spelling, and other errors are not viewed as incorrect for the purposes of this task. Only clause structure errors are directly corrected and discussed. All other errors are simply corrected through modeling or recasting.

Sentence generation. Sentence generation can be accomplished in a number of ways. In the CSI protocol, we provided a brief, two- to three-sentence "story" and a main clause followed by a blank, in order to elicit the subordinate clause (see Figure 8). This process works well for all subordinate clause types but is particularly useful for teaching object complement clauses.

Preference production. The preference production task highlights meaning contrasts between pairs of sentences that are similar in structure. It requires the student to integrate what they know about the world with the concepts encoded by the various types of complex sentence clauses. The clinician presents two sentences that are almost the same, except for one key word or phrase. The clinician and student read the sentences aloud together and then find and highlight the subordinate clause in each one. Then, the clinician will ask the student to think about what each sentence means and decide which one he or she agrees with more, or which one is true, or which one makes more sense. Some clinician assistance is usually required to make the inferences necessary to decide which sentence is the most sensible. It may also be necessary to explain vocabulary words with which the student is unfamiliar; usually, a simple explanation or synonym will suffice.

Cloze production. A more advanced discourse-level production activity, which is more challenging because it taxes memory, conceptual, linguistic, and metalinguistic resources simultaneously, is a cloze production passage. In cloze production, the clinician prepares a short reading passage that contains the target complex sentence type(s). One copy is complete, and a second copy is modified to remove the target subordinate clause(s) and replace them with blanks. This is easily done on a computer within a word-processing program. Initially, the clinician and student read the first passage aloud together. Then, the complete version is removed, and the passage is again read aloud together, stopping where the blanks are. The student is

Figure 6. Example of a completed student worksheet used for the sentence identification task. The student's response is to highlight the target subordinate clause, in this case, a relative clause.

1. I thanked the lady who helped me with directions.
2. The jacket that I found in the dryer had shrunk by two sizes.
3. The puzzle that was difficult to solve was made up of 1000 pieces.
4. Mosquitoes are small two-winged insects that can spread fatal diseases like malaria.
5. Joey offered an apology, which his girlfriend did not accept.

Figure 7. Example of a deconstructed sentence as presented in electronic format on a computer screen. The student has copied each clause using a mouse to cut and paste each clause into a "main clause and dependent clause" area, and then each is corrected to become an independent clause.

- My family belongs to the pool that has two large diving boards.
- Main clause: My family belongs to the pool.
- Relative clause: The pool has two large diving boards.

then asked to provide a clause that fits in the blank and write or type it verbatim (or dictate it for the clinician to write). The clinician should provide immediate feedback on the response. Feedback can be both structural and semantic (e.g., explaining whether the response makes sense). The clinician and student can work together on a better response and then reread, backing up a few sentences before the sentence with the filled-in target subordinate clause.

Evidence Base for CSI

Balthazar and Scott (2018) completed an early-phase efficacy study to assess treatment effects and the impact of dosage on response to CSI. Thirty-one participants, aged 10–14 years, were treated for 9 weeks in either once-weekly or twice-weekly 40- to 60-min sessions targeting complex sentences containing adverbial, object complement, and relative clauses. At the end of 9 weeks, both groups demonstrated an average 10–standard point gain (from an average of 72–82) on the primary norm-referenced language measure of the study, the Core Language Quotient of the Clinical Evaluation of Language Fundamentals–Fourth Edition (Semel et al., 2003), with the majority of the changes accounted for by the Formulated Sentences subtest scores. Performance on another primary outcome measure, the complex sentence probes, also improved for the majority of participants (see Table 1); however, results differed by sentence type, with the largest effect sizes for adverbial and relative clauses. Significant pretreatment–posttreatment gains were not found on reading and writing measures. Participants in the higher dosage condition did not perform significantly better than the comparison group; however, the relatively short period of treatment overall (9 weeks) and the fact that treatment targets were limited to two-clause sentences, among other factors, leave many questions regarding dosage unanswered. While these are not conclusive results, they do suggest that one or two 1-hr sessions per week of individual treatment aimed specifically at complex sentences could produce meaningful gains.

Figure 8. Example of the sentence generation task.

Rebels sometimes miss their targets. Yesterday the rebels succeeded. They attacked the government headquarters.

Complete this sentence with an object complement clause.

International networks reported _____.

MetaTaal

The MetaTaal approach derives from the program "Grammar in Form and Color" developed in Denmark in the early '70s for children with severe hearing problems (K. Thyme, personal communication, December 8, 2010). This intervention program targeted morphosyntactic structures by using a metalinguistic and multimodal approach. The program used LEGO bricks of various shapes and colors to depict word classes and grammatical functions. Building sentences with these LEGO bricks helped children to understand and produce grammatical sentence structures. Thyme based her approach on Freunthaller (1937), who developed a program that visualized grammar in order to teach German and foreign languages to children with severe hearing problems. Freunthaller's basic idea was that children with grammatical problems could learn morphosyntactic structures with visual support and "pattern practice." Thyme's program was never officially published, but Van Geel (1973) translated and adapted the intervention for Dutch children with DLD. The program became quite popular in the Netherlands, and LEGO provided special packages containing all the LEGO bricks needed to work with the program. In later years, the interest in the approach gradually waned, and the program was not developed further. The original versions of Grammar in Form and Color only contained material to construct simple sentences and coordinated sentences. Zwitserlood, Wijnen, et al. (2015) further adapted the Dutch Grammar in Form and Color program with LEGO bridges functioning as connectors in order to build more complex sentences. This

new version was named "MetaTaal" and was evaluated in two quasi-experimental intervention studies targeting production of relative clauses (Zwitserlood, 2015; Zwitserlood, Wijnen, et al., 2015). In these single-subject repeated-baseline designs, complex sentences containing right-branching (sentence final) and center-embedded relative clauses were selected as treatment goals. This choice was based on the results of a longitudinal study of children with DLD between the ages 6 and 10 years (Zwitserlood, 2014), which found 10-year-old children with DLD used fewer relative clauses (often containing more errors) than the typically developing age-matched control groups. The rationale behind choosing relative clauses as an intervention goal was that, if such challenging targets could be remediated successfully, this would provide evidence that older children with DLD could still benefit from therapy. Current tendencies in the Netherlands to diminish direct intervention for older children with DLD should consequently be reconsidered.

At this point, it is appropriate to elaborate somewhat on Dutch relative clauses. Relative clauses appear to be challenging for children with DLD in various languages (Zwitserlood, van Weerdenburg, et al., 2015). The different relative clause types and functions were already explained in the section on CSI; however, Dutch and English relative clauses differ in a number of ways. A first difference is that, in English object relative clauses, the relative pronoun is optional, whereas in Dutch, it is obligatory. Second, in Dutch relative clauses, gender agreement between the head noun and the relative pronoun is required. The relative pronoun can take either the common gender form "die" or the neuter gender form "dat." A third difference relates to their verb placement requirements. In Dutch, the finite verb always takes the second position in main clauses but appears in clause-final position in subordinate clauses. Because of these verb placement requirements, Dutch-embedded relative clauses with animate subjects and objects are not disambiguated by word order, as is the case in English. Such clauses can remain ambiguous between a subject relative clause reading and an object relative clause reading (4). Disambiguation can be effected by morphosyntactic means (e.g., subject–verb agreement, as in (5) or by pragmatic plausibility (6). Examples 4–6 originate from Zwitserlood, Wijnen, et al. (2015). Subscripts for singular (SING) and plural (PLU) are provided to indicate where subject-verb agreement is required in Dutch.

(4) Het konijntje$_{SING}$ (S), dat (S or O) de jager $_{SING}$ (S or O) ziet $_{SING}$, zit in het gras.
The rabbit that the hunter sees, sits in the grass
1st reading (SS): The rabbit (S), that (S) sees the hunter, sits in the grass.
2nd reading (SO): The rabbit (S), (that) (O) the hunter sees, sits in the grass.

(5) Het konijntje$_{SING}$ (S), dat (O) de jagers$_{PLU}$ (S) zien$_{PLU}$, zit in het gras.
The rabbit that the hunters see sits in the grass
Reading (unambiguous); The rabbit (that) the hunters see, sits in the grass.

(6) Het konijntje dat de jager op de korrel heeft, zit in het gras.
The rabbit that the hunter on the bead has, sits in the grass
Reading (unambiguous): The rabbit (S) (that) the hunter draws a bead on, sits in the grass.

MetaTaal is a multimodal metalinguistic intervention program, making use of visual, tactile/kinesthetic, and motor channels to teach grammatical constructions explicitly to children with DLD. Children learn to build sentences with LEGO bricks from left to right and are provided reference sheets so they do not have to memorize the functions, colors, and sizes of the bricks. The first step is to build simple, familiar sentences in order to learn the program. The second step is to combine simple sentences into coordinated clauses (see Figure 9).

In the next step, children learn that words can be moved or deleted from the sentence by construction of coordinated sentences with reduction (see Figure 10). When children get this idea, the next step in the program is to build subordinate clauses, particularly relative clauses at the end of a sentence. The LEGO bridge is placed in a vertical position, so that the relative clause is on a lower level than the main clause (see Figure 11). Children also learn that they can leave out the relative clause and still have a correct sentence, which does not apply the other way around, because the word order (final position of the inflected verb) of the relative clause is not correct for a stand-alone sentence.

The last step in the program is to build center-embedded relative clauses. Because the relative clause is positioned on a lower level, an extra bridge is used to return to the level of the main clause (see Figure 12). This second bridge gets a small corner stone on top and is called a "comma-bridge," because in written Dutch, commas are usually placed between the inflected verbs of main and relative clauses. This is the only instance that a LEGO brick does not correspond to a word in the sentence.

A more detailed description of the MetaTaal program can be found in Zwitserlood, Wijnen, et al. (2015). All therapy sessions contain several components, such as explanation of the meaning of the sentences, identification of certain sentence elements such as verb placement in main and relative clauses, conjunctions, and the relative clause position in the sentence. Construction and deconstruction of the sentences with the LEGO bricks constitute an important part of each session, and all sessions are concluded with a game.

Evidence Base for MetaTaal

In the first MetaTaal intervention study (Zwitserlood, Wijnen, et al., 2015), 12 children with DLD with a mean age of 11;2 participated (see Table 1). The children were all enrolled in a special school for children with DLD. They all received 5 hr of individual protocolled therapy during 5 weeks (30 min, twice a week). Children were treated by their own SLP, who remained blind to the results from the five different criterion-referenced tasks used to measure relative clause production and comprehension. All tasks were administered by SLPs not involved in the intervention and not familiar with the MetaTaal program. The children completed three monthly baseline measurements pretherapy, followed by a measurement directly posttherapy and a retention measurement 3 months later. During the baseline

Figure 9. Coordinated sentences built with LEGO bricks.

and retention period, the children did not receive therapy. Results showed that the children made significant progress on two out of three relative clause production tasks, but not on the comprehension task. Subsequently, this intervention study was replicated with a group of 18 children with DLD, with a mean age of 12;9 (Zwitserlood, 2015). These children visited four different special schools for children with DLD in the Netherlands and received additional special care because of behavioral problems. Four different SLPs treated the children with the same protocolled intervention program. They were also blind to the results of all measurements until the study was finished. Results from this replication study were similar to the first study, with significant gains on the production tasks and no gains on the comprehension task. It is noteworthy that this somewhat older group of children scored higher during baseline measurements and also obtained higher scores during the posttherapy and retention measurements. Notably, it was observed in both studies that the relative clause sentence repetition task yielded no effect immediately posttherapy, but the children did improve between the last baseline measurement and the retention measurement. This interesting finding suggests that learning of complex grammatical structures may be protracted and that administering retention measurements is important.

Based on the promising results of both MetaTaal intervention studies, the MetaTaal program was expanded with other subordinate clause types, in particular, adverbial clauses with conjunctions "omdat" (because) and "als…dan" (if/when…then). With this addition, MetaTaal covers the most frequently used subordinate clause types in spoken Dutch child language. Currently, the program is used widely by SLPs in special education and private practices. To date, no further MetaTaal intervention studies have been executed, except for a small pilot study investigating the feasibility of using MetaTaal to teach English as a foreign language to Dutch adolescents with DLD (Develing, 2018). Most SLPs working with MetaTaal are members of the MetaTaal Facebook and Google discussion groups. Members often report that children are motivated to work with the program and make good progress during treatment and also on standardized language measures.

Summary and Directions for Future Research

Evidence for use of the syntactic intervention approaches discussed here, with a range of people with DLD and for a range of grammatical structures, is slowly growing, but many areas remain to be investigated. All three of our approaches could also be described as treatment "packages," interventions that use a variety of tools and methods together (i.e., metalinguistic instruction, stimulus organization, multiple modalities, target selection, intervention schedule). These separate components have not been teased apart, and we therefore do not know to what extent they contribute differentially to treatment effects; however, it is not clear whether separating elements is feasible or necessary in order to make progress in maximizing treatment effectiveness. Generally, the greatest need for syntactic intervention research involves practical variables that could be leveraged to promote greater success of children with DLD and greater adoption of evidence-based practices by SLPs internationally.

Treatment Delivery

With a few exceptions, these interventions have been delivered using individualized one-on-one child/clinician

Figure 10. Coordinated sentence with reduction built with LEGO bricks.

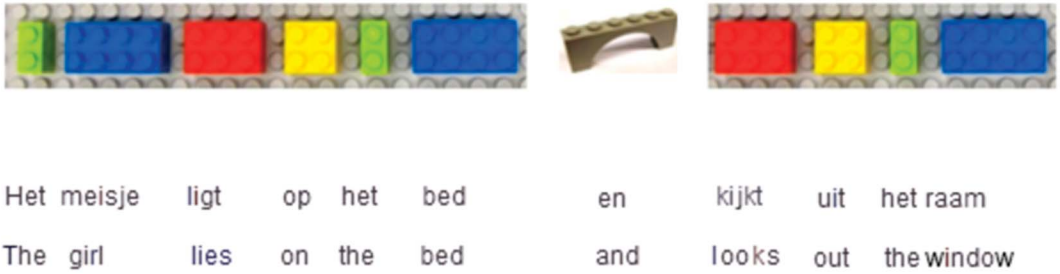


Figure 11. Sentence built with LEGO bricks containing a right-branching object-subject-type relative clause.

models. Other service delivery options should be explored, including small groups, peer-assisted, and curriculum-based models. Utilizing other agents of intervention such as parents, classroom teachers, and other special educators to deliver and reinforce intervention could also be systematically studied.

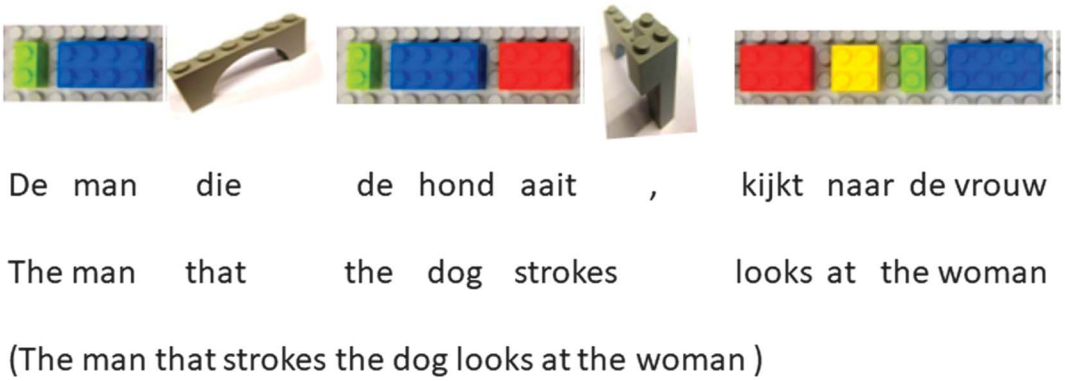
Functional Impact

To date, there is little information about the effects of our approaches long term on functional academic tasks (e.g., note-taking, reading comprehension, writing) or academic and social outcomes (e.g., graduation from high school, postsecondary degree completion, employment, self-perception, socioeconomic status). The ultimate goal of intervention is to build the types of language representations that support children's success outside of therapy. We need to determine what aspects of functioning are subject to therapeutic changes and over what time span.

Target Populations

It is important to investigate the range of individuals who are likely to benefit from syntactic intervention approaches like ours. One factor that has to be investigated further is the age of the children. A certain level of metalinguistic awareness seems to be a prerequisite for metalinguistic approaches. However, we do not know from what age onwards children can benefit from these approaches. Expanded treatment studies that include not only children and adolescents with DLD but also those with comorbidities such as autism spectrum disorder, mild intellectual disabilities, or hearing impairment should also be considered; indeed, such research has started with the SHAPE CODING system, but on a very small scale (Ebbels et al., 2014; Newton et al., 2017; Tobin & Ebbels, 2019). MetaTaal is being developed to offer a version for younger children, with more simple sentence frames, expansion of the number of constituents/arguments, and more different types of coordinated sentences. Efforts such as these need to be increased, and their efficacy needs to be researched.

Figure 12. Sentence built with LEGO bricks containing a center-embedded subject-subject-type relative clause.



Dosage

Research on dosage in interventions for children with DLD is rather limited (Proctor-Williams, 2009). Although Balthazar and Scott (2018) found no treatment advantage for a higher dosage group that received intervention twice a week, the variations on dosage and their relationships to various possible outcomes and durations were very limited in that study. In both MetaTaal intervention studies, the children were treated twice a week in a special education setting, while the majority of the studies on the SHAPE CODING system were delivered once a week. While the aforementioned studies as well as anecdotal evidence suggest that treatment once a week produces positive effects, much remains to be evaluated in terms of the optimal dosage for grammatical intervention. Systematic examination of dosage factors such as stimulus frequency and density should also be undertaken, in order to maximize inductive learning based on statistical learning principles (Plante & Gómez, 2018).

Measurement

Because children with DLD are a heterogeneous group when it comes to language symptoms, there is a need for appropriate measurement tools to help SLPs identify which children need this type of intervention and which areas of grammar to target. We know that two children with the same overall scores on a comprehensive language test can look quite different when patterns of language strengths and weaknesses are examined more closely. We are interested in not only who can benefit but also, perhaps more importantly, who can benefit the most. Studies to date have suggested that intervention might have the greatest impact on children with the lowest performance; however, this remains to be systematically studied under a variety of operational definitions of "low performance" and "benefit."

In addition to identifying which children should receive syntactic intervention, additional research and resources are needed to support comprehensive assessment of grammatical problems so that specific targets can be selected for individual children. Standardized language tests do not provide clinicians with an in-depth analysis of morphological or syntactic features. Current methods include language sample analysis (Heilmann, 2010) for assessing children's spoken or written language and picture selection or sentence repetition tasks to assess language knowledge and comprehension. Balthazar and Scott (2017) advocate for constructing criterion-referenced tasks and dynamic assessments in order to increase the specificity and ecological validity of the assessment. Although published methods such as these can be used or adapted for any age, language, or genre of language, it requires extensive clinician knowledge and training, as well as preparation and analysis, to make such adaptations and interpret the results. An increased number of ecologically valid and flexible measurement tools, such as the Coloring Book Test (Pinto & Zuckerman, 2019), act-out tasks using toy figures (Ebbels & van der Lely, 2001), and real-time paraphrasing (Balthazar & Scott, 2014; S. L. Gillam et al., 2009), need to be developed, investigated, and disseminated for use. A much more robust evidence base is needed supporting use of such methods for collecting detailed information about children's syntactic knowledge.

SLP Training and Resources

In order to effectively implement intervention approaches as the evidence base expands, additional training and intervention resources need to be developed and evaluated. It is critical that SLPs have access to training that provides a good knowledge base of grammar in their home language; for SLPs who work with multilingual children with DLD, it may be necessary to know this information for other languages spoken frequently in their countries.

Currently, there are some training opportunities available for the three approaches presented here. For MetaTaal and the SHAPE CODING system, these include 1-day courses (either face-to-face or online for the SHAPE CODING system) to equip SLPs, teachers, assistants, and parents with the basic knowledge to be able to use the approach. However, the specialist knowledge of an SLP is required to identify the grammatical targets and when and how to move on to new targets. It is likely that others will have difficulty implementing the system without the support of a trained SLP, even if they have attended a basic training course. Training in the SHAPE CODING system also includes more advanced levels aimed at SLPs (and specialist teachers with good knowledge of linguistics) needing to code and teach more advanced syntactic structures. CSI training workshops have been provided on-demand but are not broadly or frequently available. Considerable work is needed to improve the availability and effectiveness of training for increasing clinicians' ability to identify and intervene with syntactic targets.

Another area of future development is resources. The SHAPE CODING system has released an app, suitable for use on both Android and Apple tablets. A CD of printable resources is also available, and there are plans to convert these into downloadable resources in the near future as technology continues to move forward. For MetaTaal, sets of LEGO bricks, the printed program, and criterion-referenced tasks are currently available, with a new version (under construction) for younger children with DLD and an app under development for use during therapy and at home. The three approaches discussed here are developing in terms of the evidence base, training courses, and resources, and these three areas are rightly closely linked; as the evidence base develops, so training and resources can follow.

Conclusion

The purpose of this article has been to summarize the reasoning and methods employed in three explicit grammatical intervention approaches and to map a way forward for clinically useful research in this area. Considering the empirical basis for our syntactic intervention approaches,

we suggest that SLPs select specific syntactic targets based on careful and individualized analysis. Furthermore, we recommend the use of implicit learning principles in combination with explicit metalinguistic instruction, accomplished through intentional selection and organization of stimulus materials and supported with learning activities presented in multiple modalities. Although treatment scheduling and dosage evidence is sparse, we recommend an intervention schedule involving at least one individual 30-min session per week. Moving forward, more efficacy research is needed that investigates the optimal distribution of learning episodes, includes languages other than English, and addresses a variety of types of language disorders. As the evidence increases, practical clinical tools to guide target selection, measurement of outcomes, and decisions about how to tailor interventions to individual needs must also be developed and disseminated in order to maximize both the effectiveness of the intervention and the adoption of syntactic interventions by clinicians around the world.

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