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Phonological and morphosyntactic intervention for a twin pair

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Abstract
Two 6-year-old male fraternal twins each received 8 weeks of morphosyntactic and phonological intervention in counterbalanced order. Progress occurred for most targets and measures, with each child making greater progress for either phonology or morphosyntax during the corresponding unitary-domain block. Gains were maintained during the subsequent alternate treatment block. Possible indirect changes in the non-treated domain were also observed in global measures. The data suggest that at least some school-aged children with concomitant difficulties in morphosyntax and phonology, perhaps those with significant constraints in each domain, can benefit from sequences of unitary-domain intervention. This study invites further research concerning many unresolved clinical issues for school-aged children with protracted development in both phonology and morphosyntax.

Keywords
Grammatical morphemes, language therapy, phonological therapy, sentence structure

1 Introduction

Children with protracted development in both phonology and morphosyntax constitute a substantial fraction of clinical caseloads (Shriberg and Austin, 1998). When planning interventions for such children, speech-language pathologists (SLPs) and other interventionists may question which

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domain(s) to target, in what order or dosage to address them, and whether to expect inter-domain treatment effects. Research evidence pertaining to these questions is scarce. For the present investigation, a pair of fraternal twins participated in intervention focusing on each domain in a counterbalanced order. The primary goal was to effect change in both domains, investigating whether intra-domain progress would occur and be maintained in the subsequent alternate treatment block.

Few studies have evaluated interventions for both phonology and morphosyntax, especially within children. Furthermore, the research has focused on preschoolers. Results have been equivocal in terms of direct and indirect effects between individuals or groups of children. Regarding effects of whole language or morphosyntactic interventions, Tyler and Sandoval's (1994) quasi-experimental small-*n* study and Fey et al.'s (1994) randomized controlled study found only direct effects on morphosyntax. In contrast, two randomized controlled studies (Matheny and Panagos, 1978; Tyler et al., 2002), and a twin case study (Hoffman et al., 1990), found direct effects on morphosyntax and indirect effects on phonology. Regarding effects of phonological interventions, two case studies (Hoffman et al., 1990; Seeff-Gabriel et al., 2012) and two randomized controlled studies (Almost and Rosenbaum, 1998; Tyler et al., 2002) found only direct effects on phonology. The small-*n* study of Tyler and Sandoval (1994) and the randomized controlled study of Matheny and Panagos (1978) found both direct effects on phonology and indirect effects on morphosyntax. Thus, even studies with higher levels of experimental control disagree about the likelihood of cross-domain effects in either direction. Variability across studies regarding the severity of the children's difficulties, intervention strategies, and outcome measures likely contributed to the inconsistent results.

Although most studies observed treatment effects within the targeted domain, even this cannot be assumed for children with concomitant morphosyntactic and phonological difficulties. In Tyler and Watterson's (1991) study, neither treatment group showed significant change in phonology or morphosyntax, regardless of which domain had been targeted. Also, Smith-Lock et al. (2013) found that 5-year-olds who received an expressive grammar intervention made significant progress in morphosyntax as a group, but individual-level analyses indicated that children who had not passed an articulation screening showed no significant gains.

Given the inconsistent findings regarding cross-domain effects and the lack of data for school-aged children, the prudent course would seem to be to target both domains for older children with more severe concomitant difficulties. To our knowledge, Tyler et al. (2003) is the only study to have compared different sequences of intervention: phonology-first, morphosyntax-first, weekly alternations between domains, and simultaneous. All treatment groups showed positive changes in phonology and morphosyntax at the end of 24 weeks of biweekly sessions. The alternating condition had a greater effect on morphosyntax. However, high levels of within-group variability showed notable individual responses to the various treatment conditions.

Another question concerning sequential interventions is whether within-domain gains will be carried over (i.e. progress further) or maintained in a subsequent block of intervention focusing on another domain. Tyler et al. (2002) found such effects: the phonology-first group showed phonological changes indicating carryover during the subsequent morphosyntax block, and the morphosyntax-first group showed morphosyntactic changes indicating maintenance during the subsequent phonology block.

Regarding within-domain treatment strategies, a variety of approaches exist, with no clear evidence for the optimal approach (for phonology see Baker and McLeod, 2011; for morphosyntax see Ebbels, 2014; Eisenberg, 2013). Intervention strategies for phonology focus relatively more on input (e.g. awareness-building, perceptual contrasts) or output (e.g. imitation, successive approximation, production of contrasting and/or similar phonological forms) (Williams et al., 2010). For morphosyntax, there is some support for strategies that target inconsistently produced forms that

are developmentally suitable. Explicit instruction strategies (e.g. imitation, contrastive modeling) that provide multiple iterations of targets to be practiced may also be critical for children with slower learning rates. Productive use of morphosyntactic targets may require strategies (e.g. recasting) and therapy contexts that more closely parallel natural language use. Although comparative studies are lacking, a combination of explicit instruction and scaffolding procedures could produce best outcomes in morphosyntactic development (Eisenberg, 2013; Fey et al., 2003).

In order to investigate further the effects of treatment for children with concomitant difficulties in morphosyntax and phonology, a pair of 6-year-old fraternal twin boys participated in two case studies with unitary-domain treatments (morphosyntax and phonology) in counterbalanced order. Twins offer a degree of quasi-experimental control because of their similar environmental experiences and genetic makeup, although identical twins are more similar than fraternal twins (Munsinger and Douglass, 1976). Specific questions were:

1. whether treatment effects would be observed after domain-specific intervention; and
2. whether changes observed in the first treatment block would be maintained or carried over following treatment for the other domain.

II Method

1 Participants

Participants were two monolingual Canadian English-speaking twin boys, aged 6 years 7 months (grade 1), previously diagnosed with significant speech and language delays. Their first words appeared after age two, and word combinations around age 4. Both children have normal hearing. The parents attended the Hanen Centre's *It takes Two to Talk® program* (http://www.hanen.org) when the boys were three. From age four, the twins have received speech-language services. Near the end of the current study, a specialized team diagnosed the twins with Autism Spectrum Disorder (ASD). One twin (Morgan, pseudonym) appeared conscious of his communication difficulties, and was reticent at first with the investigators. Nonetheless, both boys showed interest in communicating and sharing with familiar adults. The investigators, the school-based team, and the parents agreed that the domains targeted in this study corresponded to the twins' most urgent needs given their impact on communicative, social, and academic success.

2 General procedures: Testing

The timing of the assessments and the intervention blocks were constrained by the school calendar and the availability of the family and the student clinicians. Preliminary baseline data were collected four months prior to the onset of therapy to obtain information on the children's abilities, needs, and preferences, and to develop a detailed pre-treatment assessment plan. For the first 7 weeks of this baseline period, both children received weekly school-based speech-language intervention that targeted social skills and language skills. During the intervention phase, three full assessments were completed for each participant: (1) immediately *pre-treatment*; (2) four weeks *post-block 1* (between the two treatment blocks); and (3) three weeks *post-block 2*. Assessments (audio- and video-recorded) were conducted by the university team of clinician-researchers in collaboration with the parents. (Table 1 outlines the study design.)

Table 2 presents the pre-treatment assessment data. Notable difficulties were confirmed in speech and language production. Language comprehension was not assessed in depth, but was deemed a relative strength based on interactions and observations. Scores for non-verbal skills were borderline average.

Table 1. Overview of the study design.

Period	Activities	
	Morgan	Philip
Assessment	Baseline assessment	Baseline assessment
Baseline period: 16 weeks	Regular speech and language; intervention: 7 weeks; no treatment: 9 weeks	Regular speech and language; intervention: 7 weeks; no treatment: 9 weeks
Assessment	Pre-treatment assessment	Pre-treatment assessment
Block 1: 12 weeks	Morphosyntactic treatment: 8 weeks; break: 4 weeks	Phonological treatment: 8 weeks; break: 4 weeks
Assessment	Post-block 1 assessment	Post-block 1 assessment
Block 2: 11 weeks	Phonological treatment: 8 weeks; break: 3 weeks	Morphosyntactic treatment: 8 weeks; break: 3 weeks
Assessment	Post-block 2 assessment	Post-block 2 assessment

3 General intervention design

The design consisted of two case studies. Both children received two 8-week blocks of one-hour, weekly sessions. By random selection, Morgan received morphosyntax-first treatment (hence Morgan), whereas Philip received phonology-first treatment (hence Philip). Intervention goals were chosen to suit each child (see below). Due to the children's significant difficulties and reported slow progress, and the large team of interventionists (student clinicians, university supervisors, educational assistants, parents, school-based SLP), unitary treatment blocks were provided for each domain. During the first block of treatment, within-domain progress (direct effect) was expected, with possible indirect effects for the other domain. During the second block, progress was again expected in the targeted domain (direct effect), with possible maintenance or carryover in the previously targeted domain. Because each child received two different blocks of intervention, comparing across blocks neutralized maturation effects and made it possible to consider relative change within each domain. Each child thus served as his own control.

Two final-year Master's students in speech-language pathology conducted the intervention under supervision. This involved weekly meetings (supported by audio- or video-recordings) with their university-based professors (also SLPs) in order to maintain fidelity to the treatment design, and to plan interventions. Team meetings were held once a semester at the school. Homework was provided weekly to the parents and two school-based educational assistants (one per child). In weekly consults with the student clinicians, educational assistants reported providing four weekly 15-minute practices and the parents reported five to six. The mother (a trained teacher) worked with one child at a time in a closed room and kept treatment goals and activities separate for each child. During the treatment period, the school-based SLP provided occasional service (not weekly); she was informed of each child's targets and did not address the untargeted domain. This supplementary therapy thus provided additional focus on the goal area for each block.

4 Specific methods: Phonology

a Target selection. Baseline and pre-treatment assessments from the Computerized Articulation and Phonology Evaluation System (CAPES; Masterson and Bernhardt, 2001) provided data for target selection (86 single words). The student investigators (authors 1 and 2) transcribed the

Table 2. Pre-treatment assessment data.

Area evaluated	Test	Morgan	Philip
Oral motor skills	OSMSE[a]		
	• Structure	Pass	Pass
	• Function	Pass	Pass
	• Diadochokinesis	Did not pass	Did not pass
Syllable repetition	SRT[b]		
	• 2 syllables	4th percentile	At ceiling
	• 3 syllables	<1st percentile	<1st percentile
	• 4 syllables	<1st percentile	<2nd percentile
Phonology	CAPES[c]		
	• Percent consonant match	70%	63%
	• Percent word shape match	79%	81%
	• Percent vowel match	93%	80%
Language production, comprehension, and processing	CELF-4[d]		
	• Word structure	<1st percentile	<1st percentile
	• Recalling sentences	n/a	<1st percentile
	• Formulated sentences	<1st percentile	<1st percentile
	• Sentence structure	<1st percentile	5th percentile
	• Number repetition-forward	<1st percentile	1st percentile
	Language Sample (2nd telling)[e]		
	• MLU (mean length of utterance) in words	1.9	4.1
	• Number of different words	15	60
Visual sequential memory	ITPA[f]		
	• Visual/sequential memory task	15th percentile	14th percentile
Non-verbal intelligence	TONI-3[g]	13th percentile	16th percentile

Notes. [a]Oral speech mechanism screening examination (St Louis and Ruscello, 2000); [b]Syllable Repetition Task (Shriberg and Lohmeier, 2008). Percentiles based on 50 consonant targets repeated accurately by typical 6-year-olds; [c]Computerized Articulation and Phonology Evaluation System (Masterson and Bernhardt, 2001); [d]Clinical Evaluation of Language Fundamentals, 4th edition (Semel et al., 2003); [e]Mean values for children within 6 months of the twins' age for retell of *Frog where are you?* (Mayer, 1969): MLU-w = 7.5 (*SD* 1.1); NDW (number of different words) = 100 (*SD* 19) (SALT Story retell database, Miller and Iglesias, 2006); [f]Illinois Test of Psycholinguistic Abilities (McCarthy and Kirk, 1961); [g]Test of Nonverbal Intelligence, 3rd edition (Brown et al., 1997).

samples, calculated agreement (88% for all phones and diacritics), and resolved discrepancies through discussion. A nonlinear framework was adopted for analysis and goal-setting in order to provide the most comprehensive view of a phonological system in terms of word structures, segments (consonants or vowels), and features (Bernhardt and Stemberger, 1998).

Table 3 lists acquired and unacquired structures and features/segments pre-treatment. A 75% match was set as the acquisition criterion (Olswang and Bain, 1985). (Vowels exceeded this level throughout and are not reported.)

Mismatch patterns were generally typical. Word structure mismatches included deletion of initial unstressed syllables (e.g. *again* /əˈgɛ̃n/ [gɛ̃n]) and /s/-deletion in clusters (e.g. *star* /ˈstaɹ/ [ˈtaɹ]). Common segmental substitutions included: [f] and [d] for /θ/ and /ð/ respectively; alveolars for palatoalveolars (affricates appearing as stops word initially and fricatives elsewhere); [w] for syllable-initial /ɹ/; and vowels for syllable-final /ɬ/ (Morgan). A less common substitution was [ɚ] for syllabic /l̩/ (both twins) (e.g. *whistle* /ˈwɪsɬ/ [ˈwɪsɚ]).

Table 3. Pre-treatment assessment: Acquired and unacquired structures and features.

Structures		Morgan	Philip
Length	Acquired	1- and 2-syllable words	1- and 2-syllable words
	Unacquired	3+-syllable words	3+-syllable words
Stress	Acquired	Sw, swS	Sw, swS
	Unacquired	wS, wSw, Sww	wS, wSw, Sww
Word shapes	Acquired	CV(C), CVCV(C), CCVCCVC, CVCCVCV	CV(C), CVCV(C)
	Unacquired	All others	All others
Clusters	Acquired	Stop-/w/	Stop-/w/ Stop-/ɹ/
	Unacquired	/s/-C Stop-/l/ Nasal-stop Stop-/ɹ/ Other: /lf/	/s/-C Stop-/l/ Nasal-stop Other: /lf/, /kɹ/
Positions	Acquired	WI, WM voiced stops WF /ɹ/ WI /l/	WI, WM voiced stops WF /ɹ/ WI, WM /l/
	Unacquired	WI, WM /ɹ/ WM, WF /l/	WI, WM /ɹ/ WF /l/
Features /segments	Acquired	[+nasal] [–continuant] (stops) Labial (p, b, m, f, v, w) Coronal [+anterior] (t, d, n, s, z) Coronal [+grooved] (s, z) Dorsal (k, g, ŋ)	[+nasal] [–continuant] Labial Coronal [+anterior] Coronal [+grooved] Dorsal
	Unacquired	Coronal [–anterior] (ʃ, ʒ, tʃ, dʒ) Coronal [–grooved] (θ, ð) [–continuant]–[+continuant] (tʃ, dʒ)	Coronal [–anterior] Coronal [–grooved] [–continuant]-[+continuant]

Notes. Acquired = 75%+ match; S = Strong/stressed; s = secondary stress; w = weak/unstressed; C = consonant; V = vowel; affricates and all coronal fricatives except interdentals have tongue grooving, [+grooved]; WI = word initial, WM = word medial, WF = word final; parentheses denote both forms: CV(C) = CV, CVC.

Potential word structure targets for both boys included multisyllabic words, words with initial unstressed syllables (wS, e.g. *again*, or wSw, e.g. *banana*; w = weak or unstressed, S = strong or stressed), and /s/-clusters. Possible new segmental targets included dentals /θ, ð/ ([–grooved]) and palatoalveolar fricatives /ʃ, ʒ/ ([–anterior]) and affricates /tʃ, dʒ/ ([–anterior] [–continuant][+continuant]). Liquids /l/ and /ɹ/ were emerging in one or more word positions and were thus potential word position targets (although they were still developing segmentally).

Stimulable targets were selected (Rvachew and Nowak, 2001) because of the twins' previous slow progress in therapy, their age and level of awareness of their difficulties, and the relatively small number of intervention hours compared with most intervention studies (Baker and McLeod, 2011). Interdentals and palatoalveolars were not addressed because of their lower impact on intelligibility in comparison with syllable maintenance, /s/-clusters, and the /l/–/ɹ/ contrast. The twins' phonology was similar enough that the same goals could be selected:

- Goal 1: Word structure: wS(w) and Sww. Maintenance of weak syllables in 2- and 3-syllable words with wS, wSw, and Sww (*E-le-phant*) stress patterns.
- Goal 2: Word structure: Word-initial /s/-clusters /st/, /sp/, /sn/. The twins produced word-initial stop-glide clusters but only singleton /s/. Thus, /s/-clusters were targeted with well-established stops and nasal /n/. Generalization to other /s/-clusters was possible.
- Goal 3: Position/feature: /l/ and syllable-initial /ɹ/. The liquids were both positional and feature targets. Because /ɹ/ is considered Coronal [–anterior], generalization to other [–anterior] consonants (palatoalveolars) was possible.

b Intervention. Treatment was provided using a modified cycles approach (following Hodson and Paden, 1991). The first session addressed the first goal, the second and third sessions reviewed the first or second goal and addressed the second or third, and the fourth session revisited all goals. This treatment plan was then repeated (sessions 5–8). Awareness-building activities (auditory bombardment, perceptual contrast activities) predominated in sessions 1–4, and production activities in sessions 5–8. For production, the child was asked to utter the target either in isolation (if a consonant) or in single words, first in imitation, and then in elicited non-imitative contexts. Across sessions, treatment words were elicited in increasingly longer phrases, and finally in conversation.

5 Specific methods: Morphosyntax

Initial data regarding the twins' morphosyntax were obtained at baseline via play. The boys participated willingly, but used mostly simple language (and sound effects) and had low intelligibility. Thus, a more predictable and structured elicitation context that was likely to invite more complex language was used for language sampling in subsequent assessments.

Narrative samples were collected pre-treatment and following each treatment block. Each child was instructed to look through a wordless picture book and then tell the story to a naive listener. To keep them engaged, two stories comparable in length, structure, and complexity alternated over the three time-points: pre-treatment and post-block 2, *Frog, where are you?* (Mayer, 1969); post-block 1, *Frog on his own* (Mayer, 1973). For each assessment, the children produced two narratives separated by one day, during which their mother told them the story once. This process provided a model of an elaborated story and a larger data set (through collapsing of the two narratives). The narratives were transcribed according to the Systematic Analysis of Language Transcription conventions (SALT; Miller and Iglesias, 2006). Following an initial transcription, the student clinician and supervisor responsible for the morphosyntactic treatment listened to the samples together, discussed discrepancies, and reached consensus. This procedure was necessary given the participants' low intelligibility.

Utterances were segmented into communication units (C-units) as defined by Loban (1976), a C-unit consisting of one main clause and any dependent phrase(s) or clause(s). Tangential comments, questions to the examiner, responses to clarification requests, and abandoned or completely unintelligible utterances were excluded, as were mazes (i.e. filler words, false starts, revisions, and repetitions).

a Pre-treatment language sample data. Pre-treatment, Morgan produced short stories (41 C-units) consisting of short, simple utterances (mean length of utterance in morphemes, MLU-m = 2.1) with numerous omissions of function words, bound morphemes, and verb arguments, and few different words (number of different words, NDW = 33) (see Table 4). Tense marking was limited. Instances

Table 4. Global measures and unacquired morphosyntactic elements.

Participant	Measures	Treatment block order		
		Pre-Tx	Post-Msyn Tx	Post-Phon Tx
Morgan	Global measures			
	• Total utterances	41	61	76
	• MLU-m	2.1	4.8	5.6
	• NDW	33	111	133
	Verb elements			
	• 3s	1/1	3/3	5/5
	• -ed	0/0	0/0	0/0
	• Indeterminate tense	0/13	0/46	0/36
	• Copula (*is, am, are*)	0/6	3/4	4/8
	• Auxiliary (*is, am, are*)	0/1	2/7	0/7
	Arguments			
	• SNP	12/28	42/60	46/61
	• ONP	6/8	28/29	26/27
		Pre-Tx	Post-Phon Tx	Post-Msyn Tx
Philip	Global measures			
	• Total utterances	94	100	169
	• MLU-m	4.2	4.8	5.5
	• NDW	88	112	144
	Verb elements			
	• -3s	0/0	1/1	0/0
	• -ed	0/0	0/0	0/0
	• Indeterminate tense	0/50	0/56	0/102
	• Copula (*is, am, are*)	0/14	0/8	2/15
	• Auxiliary (*is, am, are*)	1/15	3/13	0/28
	Arguments			
	• SNP	63/81	75/91	108/143
	• ONP	37/37	37/41	73/74

Notes. Data for tense markings, morphemes, and arguments correspond to produced/obligatory contexts; Phon = phonology; MSyn = morphosyntax; MLU-m = MLU in morphemes, NDW = number of different words; SNP = subject noun phrase, ONP = object noun phrase.

where the target tense was ambiguous were coded as indeterminate tense omissions.[1] Irregular past tense forms were absent, as were copula/auxiliary *be*, and other auxiliary (*do* or *have*) or modal verbs. Argument omissions were frequent, mostly subject noun phrases (SNPs) and occasionally object noun phrases (ONPs). Labeling – using a noun phrase or prepositional phrase (PP) to describe a picture – was the most frequent sentence type (32% of sentences). Simple sentences (intransitive, transitive, and copula structures) represented 65% of utterances; less than one-sixth of these utterances were complete, however, mainly due to SNP omissions.[2] Only one complex sentence was attempted.

Pre-treatment, Philip produced generally short and simple utterances (MLU-m = 4.2) with numerous omissions of function words and bound morphemes, and occasional verb argument omissions (see Table 4). Tense marking was limited, with tense omissions dominating. Copula/

auxiliary *be* and other auxiliary or modal verbs were absent. Simple sentences made up 83% of utterances, complex sentences 7%, and labeling 10%. Two-thirds of sentences had all obligatory arguments, with incomplete structures generally resulting from omission of the SNP or copula.

b Target selection. From the baseline data and pre-treatment language samples, language probes were devised for each child to confirm goals (one week prior to the start of treatment) and to serve as measures of change for specific targets after each block. All probe tasks involved elicited production rather than imitation. Activities were designed to make the target forms extremely salient, by using repetition, predictable sentence frames (e.g. *bats can see in the dark; bees can make honey*), and alternating between the child and the adult. This provided many opportunities for the child to produce the target and for the student clinician to model throughout the activity and recast as appropriate.

The investigators selected three goals for morphosyntactic production for each participant based on developmental data, stimulability, and perceived importance for the language system or communicative success (Eisenberg, 2013; Fey et al., 2003).

Morgan's goals were:

- Goal 1: More complete simple transitive sentences, emphasizing inclusion of all obligatory arguments (particularly the subject).
- Goal 2: Catenative *hafta* ('have to'). Given that modals were absent, and that catenatives (e.g. *gonna* and *hafta*) often appear early (Hadley, 1998), *hafta* was targeted.
- Goal 3: Modals *can* and *can't*. This goal served both to stimulate modal verbs (Leonard et al., 2007) and provide a more advanced way to express negation. One instance of negation appeared in the pre-treatment sample ('no fall down'), with similar utterances heard in conversation.

Philip's goals were:

- Goal 1: Complex sentences using *because.* Pre-treatment, Philip produced utterances linking clauses with *and* or *because* three times (in 94 utterances). Further use of complex sentences was thus targeted.
- Goal 2: Copula *is.* The copula was viewed as a potential springboard for the *be* auxiliary (Cleave and Rice, 1997).
- Goal 3: Modal *don't + infinitive*. This target served both to stimulate modal verbs and provide a more advanced form to express negation. Philip occasionally produced *can*/*can't* pre-treatment, but systematically substituted *no* for *don't*.

c Intervention. For morphosyntax, the three language goals were targeted each session because of the participants' previous slow progress in therapy. Activities were designed to elicit natural use of the targets. Primary treatment strategies were awareness-building (auditory bombardment, recasting), and elicited production.

6 Analysis procedures

For phonology, CAPES (2001) provided quantitative measures at baseline and the three assessment points; for all but the baseline, additional target-focused probe words were included. For morphosyntax, SALT (Miller and Iglesias, 2006) and target probes similarly provided quantitative results.

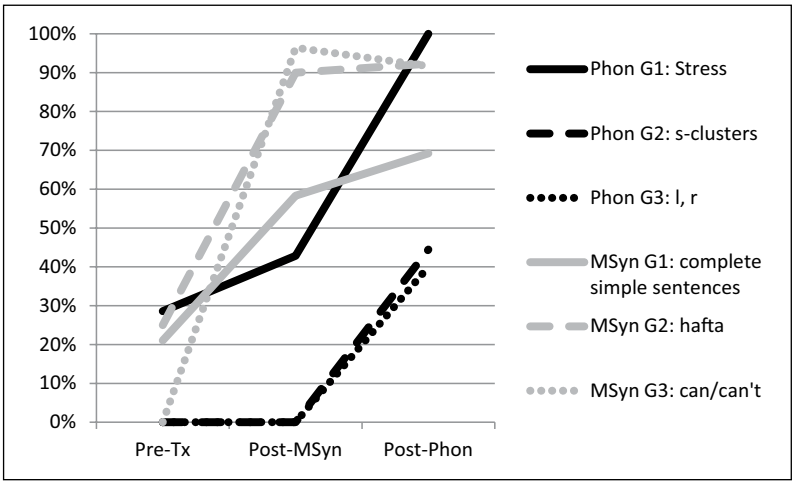

Figure 1. Data for phonology and morphosyntax treatment goals for Morgan.

III Results

Because the study aimed to evaluate within-domain effects and potential maintenance or carryover across domains, this section presents results organized by domain, first for specific treatment targets, and then for more global measures. Statistics are primarily descriptive, with inclusion of a few non-parametric analyses. An integrated summary of results for both domains then follows by twin.

1 Phonology

a Specific targets. Morgan's percentage match data for treated targets are displayed in Figure 1.

Stress patterns wSw, wS, and Sww (goal 1) showed a small increase after morphosyntactic treatment (block 1) and a greater increase after phonological treatment (block 2), whereas targeted /s/-clusters (/st/, /sp/, /sn/, goal 2) and /l/ (goal 3) increased in matches only after block 2. Syllable-initial /ɹ/ (goal 3) showed no change.

Philip's percentage match data for treated targets are displayed in Figure 2. Stress patterns wSw, wS, and Sww (goal 1) showed a large increase after phonological treatment (block 1) and a small increase after morphosyntactic treatment (block 2). Targeted /s/-clusters (goal 2) displayed a substantial increase in matches after block 1, and a smaller increase after block 2. For liquids (goal 3), syllable-initial /ɹ/ decreased in matches after phonological treatment, but increased notably after morphosyntactic treatment. Lateral /l/ (goal 3) exhibited an increase in matches after block 1 and a further increase after block 2.

Comparing treated targets between adjacent assessment points (including the baseline), a Wilcoxon's Signed Rank test indicated significant increases in matches only between post-block 1 and post-block 2 for Morgan ($p < .001$), and only between pre-treatment and post-block 1 for Philip ($p = .02$), i.e. after phonology treatments (.05 set as the critical level of significance).

b Global measures. Table 5 displays percentage match for word shapes and consonants. For Morgan, gains for word shapes and consonants were similar between baseline and pre-treatment (8%, 6% respectively), and after phonological treatment (block 2: 10%, 7%), which were slightly higher

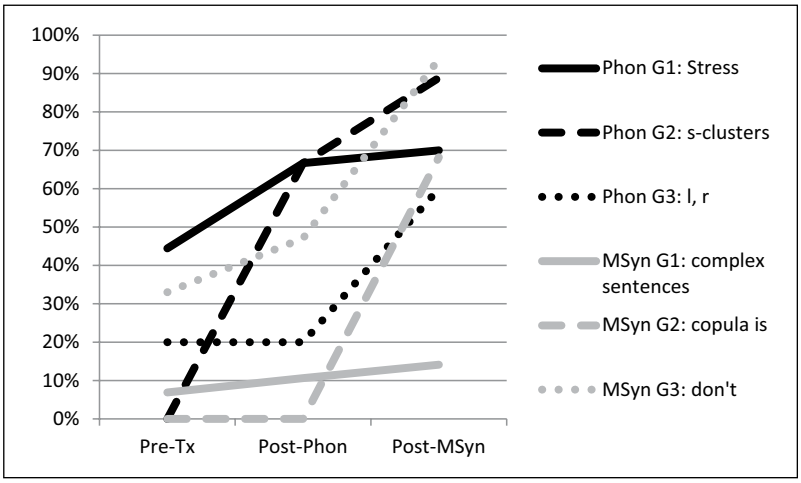

Figure 2. Data for phonology and morphosyntax treatment goals for Philip.

than increases after morphosyntactic treatment (5%, 0%). At the end of the study, word shape match was 94% (near ceiling), whereas consonant match was 77%.

For Philip, gains in percentage word shape and consonant match were greater after phonology treatment (11%, 12% respectively) than after baseline (–1%, –8%) or after morphosyntactic treatment (0%, 5%). After the phonology block, word shape match was 92% (near ceiling) and consonant match reached 75%, increasing to 80% after the morphosyntax block.

Results for all unacquired elements (treated, untreated) were evaluated across time-points and categorized into direct or indirect generalization. Direct generalization elements included: (1) treated elements in untreated word positions, i.e. word-medial and word-final /sp/, /st/, word-medial /ɹ/ and /l/, /l/- or /ɹ/-clusters; (2) untreated word-initial /s/-clusters: /sl/, /sw/, /sk/. Indirect generalization elements included: (1) untreated feature [–anterior] (from /ɹ/), and [–grooved]; (2) other unrelated clusters /nd/, /nt/, /ŋg/, /mpj/, /mp/ (although syllable-final), /kw/.

Greatest gains for unacquired elements occurred after the phonological treatment blocks. For Morgan, treated elements showed 30% match at baseline, a decline to 22% pre-treatment, an increase to 35% post-block 1, and 83% post-block 2. Direct generalization targets showed 19% match at baseline, an increase to 30% pre-treatment, continuing to 41% post-block 1, and reaching 86% post-block 2. Indirect generalization target match regressed from baseline (29%) to pre-treatment and remained low (5% to 18% match).

For Philip, gains were overall greater after the phonology block than the morphosyntax block. Treated elements were stable from baseline to pre-treatment at 48% match, increased to 78% post-block 1, and remaining stable (78%) post-block 2. Direct generalization elements increased from 21% match at baseline to 32% pre-treatment, then to 50% post-block 1, continuing to increase to 75% post-block 2. Indirect generalization elements, stable at 8% match from baseline to pre-treatment, increased to 13% post-block 1 and remained stable post-block 2 (16%).

2 *Morphosyntax*

a Specific targets. Morgan's data are presented in Figure 1. Based on narrative samples, the completeness of simple transitive or intransitive sentences (goal 1) increased from 21% pre-treatment to 58% after morphosyntax treatment (block 1). Other forms of elaboration were observed,

Table 5. Global percentage match data across assessments for word shapes and consonants.

Participant	Measure	Assessment point			
		Baseline	Pre-Tx	Post-Msyn Tx	Post-Phon Tx
Morgan	Word shapes	71% (61/86)	79% (68/86)	84% (72/86)	94% (81/86)
	Consonants	64% (147/231)	70% (163/232)	70% (158/226)	77% (174/227)
		Baseline	Pre-Tx	Post-Phon Tx	Post-Msyn Tx
Philip	Word shapes	82% (69/84)	81% (70/86)	92% (79/86)	92% (79/86)
	Consonants	71% (160/225)	63% (144/228)	75% (174/232)	80% (184/231)

Note. Phon = phonology; MSyn = morphosyntax.

including three-argument sentences and adjuncts (i.e. PPs and adverbs), which appeared in 44% of simple structures (compared with 12% pre-treatment). After phonology treatment, 69% of Morgan's simple sentences were complete. Also, 42% of simple sentences contained an additional argument or adjunct.

Probe data for *hafta* (goal 2) showed an increase in obligatory contexts from 25% (2/8) pre-treatment to 90% (9/10) post-morphosyntax, and 92% (12/13) post-phonology. Morgan produced the target form with two different pronouns and a number of different verbs. *Hafta* also appeared three times in his final narrative.

Based on probe data, Morgan went from no instances of either *can* or *can't* (goal 3) pre-treatment to achieving 96% accuracy (25/26) for *can*, and 100% (2/2) for *can't* post-morphosyntactic treatment. He produced *can* with a variety of NPs (sometimes humorously), often with the addition of adjuncts (e.g. 'ants *can* eat a pig in the water'). He also produced *can* twice appropriately in his narratives. After phonological treatment, *can* showed 85% accuracy (11/13) and *can't*, 100% (11/11). Morgan also produced *can* in conversation (i.e. 'yes I *can* show mommy') and *can't* once in his final narratives.

Combining all treated elements, significant differences between adjacent assessment points appeared only between pre-treatment and post-block 1 (Wilcoxon's Signed Rank Test, $p = .043$).

Philip's data for each goal are presented in Figure 2. The proportion of complex sentences (goal 1) increased over the study, from 7% at pre-treatment to 11% (complete in two-fifths of cases) after phonological treatment (mostly coordination with *and*) and 14% (complete in more than half of cases) after morphosyntactic treatment. Intransitive, transitive, and copula structures accounted for the majority of conjoined clauses, although one coordinated sentence included an embedded clause ('the boy open him eyes and say the froggy gone').

For copula *be* (goal 2), Philip never produced the target form in probed elicitation pre-treatment or after phonological treatment. Following morphosyntax treatment (block 2), he achieved 68% accuracy (15/22). Five tokens were in questions (e.g. 'What *is* this one?').

For *don't* (goal 3), Philip achieved 33% (3/9) and 47% (8/17) accuracy in the pre-treatment and post-block 1 structured probe activities respectively, and 94% accuracy (15/16) following the morphosyntax treatment. All utterances produced at the final assessment were self-generated responses from pictures and included many different verbs. Philip also produced *don't* unprompted during an unrelated activity, and two instances of 'I *don't* know' in the final narratives.

Combining all treated elements, no significant differences emerged between adjacent assessment points, although the difference approached significance between post-block 1 and post-block 2 (Wilcoxon's Signed Rank Test, $p = .068$).

b Global measures. Global measures and unacquired morphosyntactic elements appear in Table 4. For Morgan, large increases in productivity, utterance length, and lexical diversity were observed throughout the study. Although changes after phonological intervention (block 2) were less dramatic, all indices continued to increase.

After morphosyntactic treatment, correct tense marking (based on both obligatory tense markings and correct unmarked forms) remained stable from pre-treatment at approximately 33% in the context of greater productivity. Free-standing copula and auxiliary *is* forms occurred occasionally. After phonological treatment, morphology continued to improve. Correct tense markings increased to 50%. Use of copula *be* diversified (*is* and *are*). Regarding syntax, Morgan produced almost exclusively non-sentences and simple sentences pre-treatment, whereas his narrative sample included 28% complex sentences post-block 1. He produced non-obligatory arguments in simple sentences (goal 1, above), and began to show elaboration of the verb phrase (e.g. catenative/modal + infinitive, e.g. 'I gonna get your milk'). Complex sentences included coordination/subordination (using *and* and *so*), sentential complements (e.g. 'this girl thinks something's funny'), and infinitive complements (e.g. 'a kitty cat like to eat him'). Morgan also exhibited more complete sentences, with SNPs now produced in 70% of obligatory contexts. Post-block 2, Morgan continued to show elaboration of the verb phrase and to make use of complex sentence structures (22% of utterances). Additional elements (e.g. adverbs, PPs) began to appear in coordinated sentences. SNPs were produced with even more consistency.

For Philip, increases in productivity, utterance length, and lexical diversity occurred throughout the study but were considerably larger after morphosyntactic treatment than after phonological. Post-block 1, bound morphology in Philip's narrative sample was still limited. There was no past tense *-ed*, although irregular past did occur (15 tokens, 5 types). Copula and auxiliary *is* remained inconsistent. Correct tense marking increased slightly from 31% pre-treatment to 36% after phonology treatment. The distribution of sentence types changed little from pre-treatment (83% simple and 7% complex sentences) to post-phonology (82% simple and 11% complex sentences).

After morphosyntactic treatment (block 2), Philip showed continued increases in productivity, but relatively few changes in accuracy or diversity of free and bound morphemes. Copulas appeared in his narratives twice, although auxiliary *be* forms remained absent. Indeterminate tense omissions increased in the context of even greater productivity. The slight decrease in overall correct tense marking to 28% may be at least partially attributable to the higher number of attempts at more complex sentences, which now made up 14% of sentences produced (see goal 1 above). Obligatory SNPs and ONPs fluctuated slightly throughout.

3 Summary of results for both domains

The summary of results for both domains is presented by twin. Morgan made notable progress in morphosyntactic treatment targets, using *hafta, can*, and *can't* productively during structured activities and spontaneous speech, and maintaining them over the phonology block. His use of complete simple sentences and complex syntactic forms increased and he showed gains in global measures, including MLU, lexical diversity, and narrative length. While morphosyntactic skills increased rapidly after morphosyntactic treatment, global indices also showed steady gains following the phonology block, i.e. maintenance and continued improvement. For phonology, Morgan showed gains in accuracy particularly after the phonology block (targeted second) for treated stress patterns, /s/-clusters and /l/, as well as all unacquired elements. No change occurred for /ɹ/.

For Philip, increases in phonology regarding accuracy for treated stress patterns, /s/-clusters, and /l/, and for all unacquired elements were greater following phonological treatment (targeted first) than after morphosyntactic treatment, although there was evidence of maintenance

or carryover. Accuracy of /ɹ/ decreased following phonology treatment, but increased after the morphosyntax block although no emphasis was placed on words with /ɹ/. For the specific morphosyntax goals, Philip showed gains only following the domain-specific treatment, i.e. more complete complex sentences, more instances of coordination or subordination and productive use of *don't*. Copula *is*, although improved, remained inconsistent even in structured activities. Global measures improved throughout and especially after morphosyntactic treatment, i.e. overall productivity, MLU, lexical diversity, and syntactic completeness.

IV Discussion

Two 6-year-old male fraternal twins with protracted development in phonology and morphosyntax participated in an intervention study focusing on both domains. Each child made greater direct gains during corresponding unitary-treatment blocks. Changes in the non-treated domain were primarily limited to global measures or maintenance of progress for previously targeted elements or structures. Comparing match data for treated elements (combined) across assessment points, the only significant differences in phonology occurred after phonological treatment. Changes in global measures (percentage match for word shapes, consonants) and for all unacquired elements were also greater post-phonology than post-morphosyntax treatment, although this difference was more pronounced for Philip. For morphosyntax, the greatest increases for treated elements occurred after morphosyntactic treatment, a statistically significant change for Morgan and near-significant change for Philip. Greater changes in global measures (total utterances, MLU-w, NDW) also occurred post-morphosyntax than post-phonology treatment. These results were encouraging, considering the children's profiles and reported slow rates of progress during previous interventions that simultaneously targeted both domains, and the relatively low dosage of treatment provided.

1 Clinical implications

Clinicians must make many decisions regarding intervention for children who have deficits in more than one domain, with limited research evidence regarding issues such as order, dosage, goal-attack strategies, and potential inter-domain effects. This study suggests that for some children at least, perhaps those with significant constraints in each domain, domain-specific treatment may be required (see also Tyler and Watterson, 1991). Furthermore, moving from one domain to another before reaching age-expected levels for one domain did not appear to have a detrimental effect on the first. Prior progress was either maintained or accelerated. Thus, children can consolidate and maintain language skills while receiving treatment targeting another domain. These results are consistent with those of Tyler et al. (2002) and have obvious clinical import, particularly if one is considering language and communicative abilities more broadly. Persistent focus on a single domain may result in greater asynchronies in a child's language system and thus be a less effective way to improve communicative competence.

Unitary-treatment blocks provided intensive focused intervention that led to within-domain changes over a short period. This format also made it easier to work with the parents and the other team members in terms of providing clear instructions for additional focused practice. The results do not imply that other strategies would not work well, e.g. alternating more frequently between the two domains, as suggested by Tyler et al. (2003). Currently, there is insufficient research to recommend what might work best for school-aged children with significant difficulties in both domains.

The study's general intervention design could be replicated in other school-based settings for research or clinical purposes. The treatment program for this study included detailed descriptive

assessments in each domain, weekly sessions, activities and strategies designed to support maintenance and generalization, and short weekly briefings with the educational assistants and a parent. Under these conditions, children with significant difficulties and a history of slow progress made substantial gains in a short time. The focused, language-rich environment in the sessions, at home, and in the school undoubtedly enhanced the outcomes.

Although both children eventually received a diagnosis of ASD, this fact changed neither the treatment goals and intervention approach, nor the team's perception of what needed to be the focus of intervention. Some children with ASD will present with deficits in structural language – phonology and/or morphology and syntax (Tomblin, 2011) – that may need to be an intervention priority.

2 Research implications

As a twin intervention study, this investigation can make only a preliminary contribution to the literature. Given the children's profiles and previous progress, and the importance of meeting the children's and team's needs, a flexible design was necessary. This resulted in some differences between the children's treatment programs. Specifically, the team did not consider it appropriate to target the same morphosyntactic goals for each child nor to adopt the same goal-attack strategy for each domain. In spite of these differences, general comparisons across treatment blocks were still possible. This fit the study's objectives to investigate whether intra-domain changes would occur and be maintained in the subsequent alternate treatment block.

In any intervention study, changes may occur independently of the treatment. Here, the main comparisons were between same-duration treatment blocks counterbalanced across twins, thus offering some developmental control. Other indications that most change was attributable to the intervention included the more limited change during the baseline period for unacquired phonological targets, and the lesser progress for untargeted elements than for targeted elements in each domain. Also, for Philip's phonology and Morgan's morphosyntax, persistent changes in block 2 were of lesser magnitude than changes observed in block 1. That being said, Morgan was somewhat reticent at the outset, perhaps resulting in an over-estimate of the change reported after the morphosyntax block. Also for Morgan, gains in word shape and consonant matches during the baseline period were of similar magnitude to those observed following the phonological treatment. A more extended treatment study with additional alternations in domain-specific treatment blocks and a more stringent design (including a more comprehensive baseline) would provide further support for the observed effects.

Concerning the interventionists, the design kept the clinician constant for each domain in order to give both boys the same style of within-domain treatment (i.e. a clinician-expertise focus). That each boy made greater gains within-domain may reflect this aspect of the design. The alternative solution would have presented its own challenges, however, because the clinicians would have had to change treatment styles and strategies halfway through the program with the same boy, allowing also the possibility of unintentional flow-through from phonology to morphosyntax goals or vice versa.

The possibility that inter-domain effects could occur is particularly appealing. Given its design, the current study can neither confirm nor refute the presence of specific indirect effects beyond changes observed in global measures. For instance, the targeting of uncommon monomorphemic stress patterns for English (wS, wSw, Sww) may have provided at least some support for the production of unstressed grammatical morphemes in phrasal contexts with similar stress patterns (*a DOG* = wS, *is WALKing* = wSw; *STIR with it* = Sww). Determiners and prepositions did in fact improve. Focus on *hafta, don't*, and *can't* may all have enhanced cluster production in phonology. More specific research is needed in this area. Meanwhile, clinicians might expect inter-domain

effects for global measures and be relatively confident that alternating between blocks of therapy will have stable within-domain results.

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Notes

1. For example, the target for 'owl push him' could have been simple present/past or progressive present/past. Only cases where it was possible to reliably determine the specific omission types were categorized precisely, e.g. omission of *-ing* if the auxiliary were present.
2. The criterion for completeness was inclusion of all obligatory verb arguments. Tense markers, determiners, or auxiliaries were not considered when judging completeness. Simple sentences without a copula were, however, coded as incomplete due to the absence of the verb phrase.

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References

Almost D and Rosenbaum P (1998) Effectiveness of speech intervention for phonological disorders: A randomized controlled trial. *Developmental Medicine and Child Neurology* 40: 319–25.

Baker E and McLeod S (2011) Evidence-based practice for children with speech sound disorders: Part 1 Narrative review. *Language, Speech, and Hearing Services in Schools* 42: 102–39.

Bernhardt BH and Stemberger JP (1998) *Handbook of phonological development from the perspective of constraint-based nonlinear phonology*. San Diego, CA: Academic Press.

Brown L, Sherbenou RJ, and Johnsen SK (1997) *Test of nonverbal intelligence 3*. Austin, TX: Pro-ed.

Cleave PL and Rice ML (1997) An examination of the morpheme BE in children with specific language impairment: The role of contractibility and grammatical form class. *Journal of Speech, Language, and Hearing Research* 40: 480–92.

Ebbels S (2014) Effectiveness of intervention for grammar in school-aged children with primary language impairments: A review of the evidence. *Child Language Teaching and Therapy* 30: 7–40.

Eisenberg SL (2013) Grammar intervention: Content and procedures for facilitating children's language development. *Topics in Language Disorders* 33: 165–78.

Fey ME, Cleave PL, Ravida AI, et al. (1994) Effects of grammar facilitation on the phonological performance of children with speech and language impairments. *Journal of Speech and Hearing Research* 37: 594–607.

Fey ME, Long SH, and Finestack LH (2003) Ten principles of grammar facilitation for children with specific language impairments. *American Journal of Speech-Language Pathology* 12: 3–15.

Hadley PA (1998) Early verb-related vulnerability among children with specific language impairment. *Journal of Speech, Language, and Hearing Research* 41: 1384–97.

Hodson BW and Paden EP (1991) *A phonological approach to remediation: Targeting intelligible speech*. Austin, TX: Pro Ed.

Hoffman PR, Norris JA, and Monjure J (1990) Comparison of process targeting and whole language treatments for phonologically delayed preschool children. *Language, Speech, and Hearing Services in Schools* 21: 102–09.

Leonard LB, Deevy P, Wong AMY, et al. (2007) Modal verbs with and without tense: A study of English- and Cantonese-speaking children with specific language impairment. *International Journal of Language and Communication Disorders* 42: 209–28.

Loban W (1976) *Language development: Kindergarten through grade twelve*. Urbana, IL: National Council of Teachers of English.

Masterson J and Bernhardt B (2001) *Computerized Articulation and Phonology Evaluation System (CAPES)*. San Antonio, TX: Pearson Education (formerly Harcourt Assessment).

Matheny N and Panagos JM (1978) Comparing the effects of articulation and syntax programs on syntax and articulation improvement. *Language, Speech, and Hearing Services in Schools* 9: 57–61.

Mayer M (1969) *Frog, where are you?* New York: Dial Press.

Mayer M (1973) *Frog on his own*. New York: Dial Press.

McCarthy J and Kirk S (1961) *Illinois Test of Psycholinguistic Aabilities*. Urbana, IL: Institute for Research on Exceptional Children.

Miller JF and Iglesias A (2006) *Systematic Analysis of Language Transcripts (SALT): English and Spanish*. 9th Research edition. Madison, WI: Language Analysis Lab, University of Wisconsin-Madison.

Munsinger H and Douglass A II (1976) The syntactic abilites of identical twins, fraternal twins, and their siblings. *Child Development* 47: 40–50.

Olswang LB and Bain BA (1985) Monitoring phoneme acquisition for making treatment withdrawal decisions. *Applied Psycholinguistics* 6: 17–37.

Rvachew S and Nowak M (2001) The effect of target-selection strategy on phonological learning. *Journal of Speech, Language, and Hearing Research* 44: 610–23.

Seeff-Gabriel B, Chiat S, and Pring T (2012) Intervention for co-occurring speech and language difficulties: Addressing the relationship between the two domains. *Child Language Teaching and Therapy* 28: 123–35.

Semel E, Wiig EH, and Secord WA (2003) *Clinical Evaluation of Language Fundamentals 4*. San Antonio, TX: The Psychological Corporation.

Shriberg LD and Austin D (1998) Comorbidity of speech-language disorder: Implications for a phenotype marker for speech delay. In: Paul R (ed.) *Exploring the speech-language connection*. Baltimore, MD: Brookes, 73–117.

Shriberg LD and Lohmeier HL (2008) *The Syllable Repetition Task (SRT)*. Phonology Project, Waisman Center, University of Wisconsin-Madison, WI, USA.

Smith-Lock KM, Leitao S, Lambert L, et al. (2013) Effective intervention for expressive grammar in children with specific language impairment. *International Journal of Language and Communication Disorders* 48: 265–82.

St Louis KO and Ruscello DM (2000) *Oral speech mechanism screening examination 3*. Austin, TX: Pro-ed.

Tomblin B (2011) Co-morbidity of autism and SLI: Kinds, kin and complexity. *International Journal of Language and Communication Disorders* 46: 127–37.

Tyler AA and Sandoval KT (1994) Preschoolers with phonological and language disorders: Treating different linguistic domains. *Language, Speech, and Hearing Services in Schools* 25: 215–34.

Tyler AA and Watterson KH (1991) Effects of phonological versus language intervention in preschoolers with both phonological and language impairment. *Child Language Teaching and Therapy* 7: 141–60.

Tyler AA, Lewis KE, Haskill A, et al. (2002) Efficacy and cross-domain effects of a morphosyntax and a phonology intervention. *Language, Speech, and Hearing Services in Schools* 33: 52–66.

Tyler AA, Lewis KE, Haskill A, et al. (2003) Outcomes of different speech and language goal attack strategies. *Journal of Speech, Language, and Hearing Research* 46: 1077–94.

Williams AL, McLeod S, and McAuley RJ (Eds.) (2010) *Interventions for speech sound disorders in children*. Baltimore, MD: Brookes.