JSLHR

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Intervention Efficacy and Intensity for Children With Speech Sound Disorder

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Purpose: Clinicians do not have an evidence base they can use to recommend optimum intervention intensity for preschool children who present with speech sound disorder (SSD). This study examined the effect of dose frequency on phonological performance and the efficacy of the multiple oppositions approach.
Method: Fifty-four preschool children with SSD were randomly assigned to one of three intervention conditions. Two intervention conditions received the multiple oppositions approach either 3 times per week for 8 weeks (P3) or once weekly for 24 weeks (P1). A control (C) condition received a storybook intervention. Percentage of consonants correct (PCC) was evaluated at 8 weeks and after 24 sessions. PCC gain was examined after a 6-week maintenance period.
Results: The P3 condition had a significantly better phonological outcome than the P1 and C conditions at 8 weeks and than the P1 condition after 24 weeks. There were no significant differences between the P1 and C conditions. There was no significant difference between the P1 and P3 conditions in PCC gain during the maintenance period.
Conclusion: Preschool children with SSD who received the multiple oppositions approach made significantly greater gains when they were provided with a more intensive dose frequency and when cumulative intervention intensity was held constant.

Key Words: speech sound disorder, phonological intervention, intervention intensity

Speech sound disorder (SSD) has been defined as a developmental disorder characterized by articulatory and/or phonological difficulties that impact a child's ability to be understood by others, not due to cognitive, sensory, motor, structural, or affective issues (McGrath et al., 2007; Shriberg, 2003). Within a large, diverse sample of 3-year-old children, 15.6% of the children met the criteria for SSD (Campbell et al., 2003). Most speech-language pathologists (SLPs) who have worked with preschoolers provided intervention to children experiencing difficulties with articulation and intelligibility (Mullen & Schooling, 2010). Fortunately, meta-analyses have indicated that phonological interventions are effective (Law, Garrett, & Nye, 2004; Nelson, Nygren, Walker, & Panoscha, 2006). Narrative reviews have concluded that there are a number of evidence-based intervention approaches for children with SSD (Baker & McLeod, 2011; Gierut, 1998; Kamhi, 2006; Tyler, 2008). Because a limited number of studies have compared intervention approaches, "there are few studies that show that one intervention approach is unequivocally superior to another with a particular client group" (Baker & McLeod, 2011, p. 115).

There is great need to better understand the effectiveness of intervention. Prior to comparing these approaches, it will be necessary to determine the most effective context for implementation. Knowledge of the optimal intervention intensity for each approach will be integral to this investigation. Unfortunately, little is known about the relative effects of differing intensities. A specific intervention approach may be more effective at one intensity level than at a different intensity level (Warren, Fey, & Yoder, 2007), but that information is not known.

Intervention Intensity

Warren et al. (2007) provided a conceptual framework borrowed from the medical field to stimulate a systematic investigation of differential intervention intensity. This framework included operational definitions for the constituents of intervention intensity: *dose form, total intervention duration, dose frequency, dose*, and *cumulative intervention intensity*. Many of these terms have been regularly reported (Baker & McLeod, 2011), although other intervention intensity terms have been used in the evidence base.

Dose form refers to the context of activities and interactions. It forms a continuum from a child-directed, play-based approach at one end to a clinician-directed, drill-based approach at the other end. Dose form has been

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Editor: Janna Oetting
Associate Editor: Ann Tyler
Received March 29, 2011
Revision received September 23, 2011
Accepted September 28, 2012
DOI: 10.1044/1092-4388(2012/11-0076)

reported as descriptions of the intervention procedures, which most often but not exclusively have included activities reminiscent of drill play and structured play (e.g., Gierut, 1992; Gierut, Morrisette, Hughes, & Rowland, 1996; Hoffman, Norris, & Monjure, 1990; Rvachew, Rafaat, & Martin, 1999; Saben & Ingham, 1991; Tyler, Lewis, Haskill, & Tolbert, 2002; Williams, 2000a, 2000b).

Total intervention duration is the interval for which an intervention is provided. It may be reported by either a predetermined time frame or the length of time needed to remediate an SSD (Baker & McLeod, 2011). The predetermined time frame may be due to a specific number of sessions associated with an intervention protocol or the time needed to reach a specific criterion. Baker and McLeod (2011) found that predetermined time frames for speech sound interventions have ranged from three sessions (Shriberg, Kwiatkowski, & Snyder, 1990) to 2 years (Gordon-Brannan, Hodson, & Wynne, 1992). Note that the predetermined time frame does not guarantee remediation of the SSD. Studies that have investigated the length of time needed to reach dismissal have ranged in length from 3 months (Bowen & Cupples, 1999) to 46 months (Pamplona, Ysunza, & Espinosa, 1999), with a mean duration of 12 months for phonological interventions (Baker & McLeod, 2011).

Dose frequency includes the number of sessions provided per time unit and the length of each session. Surveys of school-based clinicians have indicated that the majority of children with mild to moderate speech or language impairment received two sessions per week for 21–30 min (Mullen & Schooling, 2010). SLPs in school settings have reported using the nature and severity of disorders to determine dose frequency; however, survey data have indicated that SLPs' caseload sizes and their years of practice influenced their decisions regarding dose frequency (Brandel & Loeb, 2011). A review of intervention studies for children with SSD indicated that children in research settings were seen two to three times per week for 30- to 60-min sessions (Baker & McLeod, 2011). At this point in time, it is possible to summarize dose frequency within school and research settings, although it is unclear if greater intensity makes an intervention more effective.

Dose is the "number of properly administered teaching episodes per session" (Warren et al., 2007, p. 71). When dose has been reported, it is often referred to as the number of trials a child has produced. Dose may be a specific number of trials due to (a) an intervention protocol (for example, a child is presented with five training sets of 20 trials [e.g., Powell, Elbert, Miccio, Strike-Roussos, & Brasseur, 1998; Williams, 1991]) or (b) an approximation of what is expected in a session (for example, 80–100 responses [e.g., Elbert, Powell, & Swartzlander, 1991; Williams, 2005]). Dose may be compounded when a specific number of target productions is accompanied by other activities, for example, those that promote auditory awareness, conceptual awareness, and phonological awareness (Tyler et al., 2002).

Cumulative intervention intensity "is the product of dose × dose frequency × total intervention duration" (Warren et al., 2007, p. 72). The calculation of this intervention intensity variable results in a numerical measure of intensity. No study investigating the effectiveness of phonological intervention reported cumulative intervention intensity; however, studies that have reported dose, dose frequency, and total intervention duration in their Method sections may allow for the calculation of cumulative intervention intensity. Whereas most studies provided dose frequency and total intervention duration (Baker & McLeod, 2011), few have provided information about dose. Very little is understood about cumulative intervention intensity.

Investigations of Intervention Intensity Variables Within Phonological Intervention

Although intervention intensity variables have been reported in the phonological intervention literature, what is needed is information regarding whether or not more intensive intervention produces better outcomes than less intensive intervention. A systematic review of 17 studies investigated the effects of frequency, intensity, or duration on the speech and language skills of preschool children (Schooling, Venediktov, & Leech, 2010). Twenty-eight of the 35 calculated effect sizes were not significant. Most of the significant effect sizes (six of seven) supported the more frequent, intense, or longer interventions. These findings substantiate the idea that more intense intervention brings about better outcomes; however, these were not compelling results because most of the effect sizes were not significant. Of those effect sizes that were significant, most were related to frequency.

Early investigations that focused solely on the impact of frequency upon speech outcomes have been inconclusive. Findings have indicated that there was no significant difference due to varying intensities (Fein, Golman, Kone, & McClintock, 1956), less intensity resulted in better outcomes (Weston & Harber, 1975), and greater intensity resulted in better outcomes (Van Hattum, 1959). These early investigations' inconclusive findings may be due to the lack of control of other intensity variables—for example, total intervention duration.

One study manipulated dose frequency yet still provided children the same number of sessions. Page, Pertile, Torresi, and Hudson (1994) provided a phonological intervention to 76 preschool children either three times per week for 2 weeks or one time per week for 6 weeks, so all children received 6 hr of intervention. Both groups made significant gains from pretest to posttest, although there were no significant differences between the two groups. No gains were noted for either group during the maintenance period. Dose was not reported for this investigation, so it was not possible to calculate cumulative intervention intensity. It should be noted that the Page et al. (1994) study occurred in Australia, where the number of sessions is frequently limited. Within the United States, preschool children are often not limited to six intervention sessions due to the year-long eligibility associated with an Individualized Education Plan (IEP; Individuals with Disabilities Education Improvement

Act of 2004). A study investigating the impact of dose frequency while utilizing a total intervention duration greater than six sessions that includes dose is needed to determine if dose frequency is an intervention intensity variable that impacts phonological outcomes.

Multiple Oppositions Approach

A phonological intervention approach used to investigate the impact of intensity upon a phonological outcome will need to provide descriptions of all intervention intensity variables. The *multiple oppositions approach* (Williams, 2000a, 2000b, 2005) is one phonological intervention that has provided preliminary information about dose form, total intervention duration, dose frequency, and dose. The dose form for the first three phases is consistent with drill play, whereas the fourth phase is more child centered and consists of recasts. Total intervention duration has been reported using both a predetermined time frame of 21 intervention sessions (Williams, 2005) as well as the average time needed to reach a specific phonological criterion, which was 60 sessions (Williams, 2000a). Dose frequency consisted of two 30-min sessions per week (Williams, 2000a). Dose was recommended as 80–100 responses per session (Williams, 2003, 2005), although a dose of 20–50 responses per session has also been used (Williams, 2000a). The documentation of these variables provides the foundation necessary to investigate cumulative intervention intensity.

In addition to providing preliminary information about the intervention intensity variables, the multiple oppositions approach has a strong theoretical background. It embraces the concepts of *maximal classification* and *maximal distinction* in that it targets sound members from different manners, places, and voicing that are maximally different from one another (Williams, 2000a, 2000b, 2003, 2005), which may have a sizeable impact on a child's phonological system (Gierut, 2001; Morrisette & Gierut, 2002; Tyler, Lewis, & Welch, 2003). Regarding efficacy, the multiple oppositions approach presents with an emerging evidence base: A moderate level of evidence in the form of quasi-experimental studies supports this approach (Williams, 2000a, 2000b, 2005). In a controlled study without randomization, the multiple oppositions approach was found to have a better impact on the phonological system than two other approaches (Pagliarin, Mota, & Keske-Soares, 2009). There is a need for a larger scale, randomized controlled study investigating the efficacy of the multiple oppositions approach and its optimal intervention intensity.

The Current Study

The current study investigated the effect of intervention intensity on phonological production skills for preschool children provided the multiple oppositions approach. The study controlled for dose form and dose, allowing only dose frequency and total intervention duration to vary for the intervention conditions. The manipulation of dose frequency and total intervention duration results in equal cumulative intervention intensities for both intervention conditions. In addition, the current study provided an active control condition to allow judgments of efficacy of the intervention approach compared to the combined effects of maturation and learning how to learn in an intervention setting. The research questions were as follows:

1. Does a phonological intervention provided three times per week have a better outcome than the same intervention provided one time per week after 8 weeks?
2. Does a phonological intervention provided three times per week have a better outcome than the same intervention provided one time per week after 24 sessions?
3. Does a phonological intervention provided either three times per week or one time per week lead to continued gains during a 6-week maintenance period? If gains are made, then does a phonological intervention provided three times per week lead to greater continued gains during a 6-week maintenance period than the same intervention provided one time per week?

There were several probable findings for this study. If outcomes were based solely on the number of sessions, then one would expect significant differences to exist at 8 weeks but not after each intervention condition had received 24 sessions. If outcomes were based on a combination of factors—for example, frequency and duration—then it would be important to note if a condensed intervention condition (i.e., three times per week) or a spaced intervention condition (i.e., one time per week) would lead to better outcomes after 24 sessions. The work by Page et al. (1994) would suggest that it does not matter if the intervention is condensed or spaced. Both intervention conditions would be expected to perform significantly better than the control condition because phonological interventions have been shown to be effective (Law et al., 2004; Nelson et al., 2006). In regard to the 6-week maintenance period, three possible findings were regression, no gain, or continued gains. The work by Page et al. (1994) would suggest that there would be no gains after a 6-week maintenance period.

Method

Participants

A sample of 54 children with SSD between the ages of 3 and 5 years participated in this study. The children were identified from two cohorts. All children met state eligibility requirements for an IEP. In addition, the children met the following inclusion criteria: (a) misarticulate at least six sounds that impacted three different manner classes as documented by a relational analysis; (b) pass a hearing screening at 20 dB HL for each ear at 500, 1000, 2000, and 4000 Hz as documented by a file review; (c) present with typical speech structures and functions as measured by an oral–motor exam; and (d) receive speech services from a specific developmental preschool. The exclusion criterion was that a child could not present with *childhood apraxia of speech (CAS)*, defined as a "speech sound disorder in which

the precision and consistency of movements underlying speech are impaired in the absence of neuromuscular deficits'' (American Speech-Language-Hearing Association [ASHA], 2007, p. 1). CAS currently has no acknowledged diagnostic criteria that differentiate it from other SSDs. Inconsistent consonant and vowel errors with repeated productions and inappropriate prosody are two criteria found to be consistent within the evidence base, although these are not necessarily the only diagnostic criteria that could or should be used (ASHA, 2007). The oral–motor exam scored the accuracy of consonant–vowel repetitions for inconsistent productions as well as intonation for prosody. No child scored a 0 for both diagnostic criteria.

At initial testing, the children ranged in age from 3;0 to 5;5 (years;months; M = 4;4). Seventy-two percent of the children were boys; 28% were girls. The majority of the children were European American (81%). Of the other children, 17% were Hispanic and 2% were African American. Descriptive characteristics of the children who participated in the study, by condition, are provided in Table 1.

Procedure

Inclusion and assignment. The Sounds-in-Words subtest of the Goldman Fristoe Test of Articulation—Second Edition (GFTA–2; Goldman & Fristoe, 2000) was administered to all children to assess their production of target sounds. A relational analysis of this corpus of words was completed to determine if a child met the first inclusion criteria. Percentage of consonants correct (PCC) was calculated for the GFTA–2 single-word responses instead of spontaneous speech, using procedures outlined by Shriberg and Kwiatkowski (1982). Children who were accepted to participate in this study were then randomly assigned to one of three conditions: one-time-per-week phonological intervention (P1), three-times-per-week phonological intervention (P3), or the active control intervention (C).

A randomization and blocking procedure was employed to control for age and severity. Each participant was assigned a random number, and his or her performance was rated for age and severity. Age was assigned one of two values: younger than 4 years or older than 4 years. Severity was assigned one of three values based on PCC: *severe* (i.e., 0%–49%), *moderate–severe* (i.e., 50%–64%), and *mild–moderate* (i.e., 65%–84%). Six cells were created based on the age and severity ratings, and each participant was assigned to a cell. Participants were randomly assigned from one cell at a time to one of the three intervention conditions. This procedure was used to lessen the impact of age and severity upon the results.

Table 1. Sample characteristics, by condition.

Characteristic	Condition		
	P1	P3	C
Number	19	19	16
Gender			
Boys	15	13	11
Girls	4	6	5
Ethnicity			
European American	15	17	12
Hispanic	3	2	4
Black	1		
Mean age in months (*SD*)	52.8 (7.6)	50.6 (6.0)	51.9 (6.6)

Note. P1 = phonology intervention one time per week; P3 = phonology intervention three times per week; C = storybook intervention.

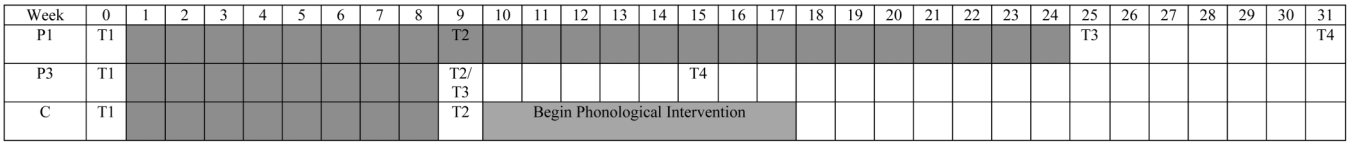
Assessment timing. Each child who participated in the study received an initial assessment, followed by an intervention period. All children were assessed at the end of 8 weeks to investigate the impact of frequency upon the outcome measure when total intervention duration was held constant for the specified time frame of 8 weeks. The P1 condition was assessed one more time after the end of the 24-week intervention period to investigate the impact of frequency upon the outcome measure when cumulative intervention intensity was equal for the two conditions. After the intervention period was completed, children in the P1 and P3 conditions received a maintenance period for 6 weeks in which no phonology target was treated, and then a final assessment was completed (at 15 weeks for P3 and at 31 weeks for P1). The children in the C condition were provided the phonological intervention as soon as the 8-week storybook intervention was completed. The children in the P1 condition were assessed a total of four times, the children in the P3 condition three times, and the children in the C condition twice. Figure 1 provides an outline of the assessment and intervention timeline.

Assessment measures. The initial assessment session was the same for all children and took approximately 45 min to complete. Each assessment was individually administered in a quiet area of the child's placement, and the phonological measure was audio recorded with a Marantz PMD 660 Field Recorder and an external desktop microphone.

The Receptive Language subtest of the Test of Early Language Development, Third Edition (TELD–3; Hresko, Reid, & Hammill, 1999), was administered for descriptive purposes. Expressive language skills were not assessed. An oral–motor exam based on the Oral and Speech Motor Control Protocol developed by Robbins and Klee (1987) was employed to rule out the presence of an organic disorder and CAS. The oral–motor exam varied from the published version due to the removal of a single-word elicitation task. Summary scores for structures at rest, oral function, speech function, and total were created. Hearing screening data were collected from each site.

The Sounds-in-Words subtest of the GFTA–2 was the basis for selecting intervention targets and calculating the outcome measure. Each response was phonetically transcribed using the International Phonetic Alphabet to allow further analyses. The Khan-Lewis Phonological Analysis—Second Edition (KLPA–2; Khan & Lewis, 2002) was used to analyze the words produced on the GFTA–2 for phonological patterns and was reported for descriptive purposes. PCC, determined from the transcription of

Figure 1. Assessment and intervention timeline for each condition. Shading indicates implementation of the intervention. P1 = phonology intervention one time per week; P3 = phonology intervention three times per week; C = storybook intervention; T1 = pretest; T2 = posttest after 8 weeks of intervention; T3 = posttest after 24 sessions of intervention; T4 = posttest after 6 weeks of maintenance.



the GFTA–2 Sounds-in-Words subtest, was the outcome measure.

Untrained target probes created by the author were utilized prior to the initiation of intervention and every third session. The untrained target probes consisted of 10 words for each target and were not addressed during intervention. Intervention data of the trained targets were collected during the sessions. Untrained target probes and intervention data were used to determine if a child met predetermined intervention criteria.

Transcription and scoring reliability. A 2-hr training in test administration and scoring was provided to graduate students prior to collecting data. After the administration training, the graduate students were presented with samples that they each scored to determine reliability. Item-by-item agreement was calculated for the TELD–3 Receptive Language subtest and the oral–motor exam during training. Consonant-by-consonant agreement was calculated for the GFTA–2. All graduate students were required to achieve 90% agreement or higher for all measures prior to completing an actual assessment.

In regard to actual data collection, six graduate students, two certified SLPs, and the author administered the initial assessments. Pretest transcription reliability was completed for 13% of the participants and averaged 87% (range = 79%–94%). An assessment protocol for each transcriber was randomly selected for each reliability check. After the initial testing period, only graduate students and the certified SLPs who were blind to the intervention conditions completed the transcriptions. Six additional graduate students blind to the intervention conditions were trained to administer the GFTA–2 using the previously described procedures. Transcription reliability was completed for 19%–28% of the participants and averaged 88% (range = 79%–98%) for the Week 8 posttest, 91% (range = 83%–95%) for the Week 24 posttest, and 91% (range = 82%–98%) for the maintenance posttest. There was an increase in the percentage of transcriptions checked for reliability due to the increase in number of transcribers to guarantee that every transcriber was part of each reliability check. Scoring reliability was completed for 22%–24% of the participants at each testing point. For the GFTA–2, there were no more than two differences in scoring, with an average of 0.3 (range = 0–1) at pretest and 0.5 (range = 0–2) at posttest. For the KLPA–2, there was an average of 1.5 (range = 0–7) differences in scoring at pretest and 2.1 (range = 0–6) differences in scoring at posttest.

Intervention

Each child was treated either singly or in a pair by one of seven SLPs who met state licensure requirements or two speech-language pathology assistants (SLPAs) within the least restricted environment as designated by each child's IEP, which consisted of 15 different sites. Nearly half of the participants were treated while they attended a developmental preschool, whereas the remainder were served in a variety of Head Start, preschool, childcare, and home settings. Thirty-six of the children were treated individually, and 18 children were treated in pairs. There were three pairs assigned to each intervention condition. If seen in pairs, then the pairs were assigned to the same intervention condition. Interventionists were assigned to condition based on availability. Three interventionists implemented intervention for only one condition, whereas six interventionists implemented intervention for three conditions.

Target selection. Targets were individually selected for each child by the author. Transcriptions from the GFTA–2 were used to complete a phonemic inventory of sounds produced in the initial and final position of words. The purpose was to determine the presence, absence, or marginal presence of each consonant sound. Once this was completed, any and all phonemic collapses were identified. For example, the phonemic collapse of correctly produced /d/ consistently replacing the sounds /ɡ, ʤ, z, ð, ɡr, dr/ would have been identified (see Williams, 2003, for more discussion). Phonemic collapses for the initial position of words were considered prior to those for the final position of words. Once a phonemic collapse was identified, one to four targets within the collapsed set were chosen. The targets were selected based on the maximally distinctive principle, so that whenever possible, different places of production, different manner classes, different voicing, and different structures (i.e., singleton consonants or consonant clusters) were incorporated into the set of targets. For each set of targets, five to eight contrastive pairs were identified using the computer program Sound Contrasts in Phonology (SCIP; Williams, 2006a). The mean number of intervention targets was 2.8 (SD = 0.6) and 2.8 (SD = 0.9) for the P1 and P3 conditions, respectively, whereas the mean number of phonemes in each targeted phoneme collapse was 7.1 (SD = 4.3) and 7.8 (SD = 5.0) for the P1 and P3 conditions, respectively.

Phonological intervention. The interventionists received 6 hr of training from the author on implementation of the

multiple oppositions approach developed by Williams (2000a, 2000b). The purpose of this approach is to teach phonemic constraints by presenting contrastive pairs that were selected based on the previously discussed maximally distinctive principle. There were three phases to the intervention: Phase 1 lasted for one session; Phases 2 and 3 lasted for as many sessions as it took for a child to meet criteria. Homework targeting speech production was not provided during the intervention study.

Phase 1 began with the interventionist explicitly sharing a rule that would lead to the development of phonemic constraints. For example, an interventionist would highlight the difference between "things that go together" and "something's missing" (Williams, 2006b, p. 29), if the purpose was to highlight the difference between a singleton consonant and a consonant cluster. This was followed by familiarization of the target words, which could be real words or nonsense words. A child demonstrated receptive understanding of a target word by pointing to it among a display of target words. Next, the child imitated the contrastive pairs. The final step was for the interventionist and child to summarize what had been targeted in that session. The interventionist wrote a note for the parents summarizing the session.

Phases 2 and 3 were similar in that they comprised a focused practice section, play activities, a wrap-up, and after-session duties. For this study, the difference between Phase 2 and Phase 3 was the context of the target. In Phase 2, the word was produced in isolation. In Phase 3, the word was produced in specified carrier sentences (e.g., "I want the ___"). Central to this approach was specific feedback after each pair's production (e.g., "You made each word sound different"). During focused practice, each child produced each contrast pair once for a total of 16–20 responses. During the play activities, each child was provided 75 (range = 65–85) opportunities to produce the targets from the focused practice, either at the word or carrier-sentence level. The child was told whether he or she would imitate or produce the targets on his or her own and was provided specific feedback for each contrastive set. Fifteen different activities (e.g., fishing, bowling, bean bag toss) were each assigned to a triad to create a total of five triads. Each session was allocated one triad, which was repeated every five sessions. The untrained target probe was administered during this step if it was required. Wrap-up consisted of the interventionist asking or telling the child what he or she did and preparing a note to go home with the child. After the session, the interventionists recorded data in the attendance chart and reviewed criteria.

Williams (2000a, 2003) provided criteria for moving from Phase 2 to Phase 3. Those criteria were also used for this study in addition to predetermined criteria within Phase 2. The first criterion was imitation of the targets in a fixed order, with 70% accuracy over two sessions. The second criterion was spontaneous production of the targets in a fixed order, with 70% accuracy over two sessions. The third criterion, which was met before movement into Phase 3, was spontaneous production of the targets in any order, with 70% accuracy over two sessions. The Phase 3 criterion was the production of the untrained target probes, with 90% accuracy.

Active control intervention. The interventionists received 2 hr of training for implementation of a storybook intervention based on Project STAR: Sit Together and Read (Justice, Kaderavek, Fan, Sofka, & Hunt, 2009). This intervention is designed to increase print awareness (Justice & Ezell, 2001) through the main instructional domains of book and print organization, print meaning, letters, and words (see the Appendix for a list of the specific targets and a brief description of each). References to letter–sound correspondences were not provided.

Each session consisted of three main steps: book reading, play activities, and wrap-up. Physical/linguistic pointing (i.e., gesturing or saying, "right here") was the primary response mode, although imitation and an actual oral response were possible responses for several targets (see the Appendix). Feedback consisted of confirmation of the target (e.g., "Yes, you showed me the title") or a model of the target (e.g., "Here is the title"). For the book-reading step, the interventionist presented a book with a specific introduction and then two unique objectives (e.g., environmental print and page order) in isolation while providing three opportunities for children to produce each target. Each child was then provided at least four opportunities to produce each target during the book reading. The interventionist used four different levels of support to elicit a response and used the lowest level needed by the children. These levels were modeling the answer, co-participation, giving choices, and recall. During the play activities, each child was provided 75 (range = 65–85) opportunities to produce the targets. The activity schedule and triads established for the phonological intervention were also used for the control intervention. During wrap-up, the interventionist either told or asked the child what had been addressed throughout the session. She then gave the child a prepared note that stated the name of the book and what had been targeted. Homework was not provided.

Intervention intensity variables. Dose form was clinician-directed for all three conditions. Total intervention duration varied for the first two research questions. For the first research question, it was 8 weeks. For the second research question, the predetermined number of sessions was 24, so total intervention duration was 24 weeks for the P1 condition and 8 weeks for the P3 condition. The C condition received a total of 8 sessions to serve as a control. Dose frequency varied by condition, so that the P1 and C conditions received one 30-min session per week, whereas the P3 condition received three 30-min sessions per week. The intended dose was calculated by adding together the minimum number of responses for focused practice (e.g., 16 from a range of 16–20) and the play activities (e.g., 65 from a range of 65–85). The minimum intended dose for the P1 and P3 conditions was 81; for the C condition, it was 79. A summary of the intended intervention intensity variables and the resulting cumulative intervention intensities is presented in Table 2.

Table 2. Intended intervention intensity variables, reported by condition.

Condition	Minimum dose	Dose frequency	Total intervention duration	Cumulative intervention intensity
P1	81	1	24 weeks	1,944
P3	81	3	8 weeks	1,944
C	79	1	8 weeks	632

Attendance. The mean number of sessions attended by the P1 group was 19.42 (*SD* = 2.06), and the mean number attended by the P3 group was 19.84 (*SD* = 2.19). No child attended all sessions due to holidays, school closures, and absences. There was no significant difference between the P1 and P3 conditions for attendance ($p = .55$).

Fidelity of implementation. The interventionists used checklists to guide each phase of the intervention. Key components for each step of a session were established, and these components were judged for completion. Each interventionist was observed at least twice for the P1 and P3 conditions and once for the C condition. The first observation took place after the third session, and the second observation took place after the 12th session. Interventionists were observed either live or via a video recording.

For each key component, the interventionist received a 0 if it was not implemented, a 1 if it was partially implemented, or a 2 if it was correctly implemented. Sixteen points were available for the focused practice, 18 for the play activities, 6 for wrap-up, and 4 for after-session, for a total of 44 points. Responses were recorded for the focused practice and play activities, as was length of session. A similar checklist and data record were created for the storybook intervention, with a total of 38 points.

Descriptive results are presented in Table 3. There were no significant differences among the conditions for accuracy ($p = .10$), actual dose ($p = .54$), and session length ($p = .98$). Three trained graduate students completed interrater reliability for 15% of the implementation observations for dose form accuracy and dose. The mean component-by-component agreement for dose form accuracy was 95% (range = 91%–100%) and for actual dose was 96% (range = 94%–99%).

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), Version 19.0. For the pretest measures, an analysis of variance (ANOVA) was conducted, with an alpha level of .05. A two-step procedure was used for analyses that compared effects of intervention. First, a preliminary analysis of the homogeneity of slopes was completed to determine whether the relationships between the outcome measure and the covariates were the same for all groups. If the homogeneity-of-slopes assumption was not violated, then a one-way analysis of covariance (ANCOVA) was conducted. The outcome measures or dependent variables were PCC for posttests and PCC gain for the maintenance period, whereas the independent variable was group. The covariates were initial PCC and receptive language. Follow-up tests were completed to determine pairwise comparisons among the adjusted means using the least significant difference (LSD) procedure, with an alpha level of .05. Effect sizes were calculated as standardized mean difference (*d*) for pairwise comparisons and partial eta-squared (η^2) for multiple comparisons. Values greater than 0.80 for *d* and 0.14 for η^2 were considered large (Cohen, 1988).

Results

Pretest Performance

The oral motor, receptive language, and phonological skills of the children at pretest were compared to determine whether the conditions were comparable prior to initiation of the intervention. There were no significant differences between the conditions for age ($p = .60$), oral–motor skills ($p = .13$), receptive language ($p = .17$), or phonological skills (GFTA–2: $p = .99$; KLPA–2: $p = .97$; PCC: $p = .91$).

Table 3. Fidelity of implementation, by condition.

Characteristic	P1 (*n* = 8)	P3 (*n* = 6)	C (*n* = 6)
Time 1: Completed after 3rd session			
Dose form accuracy (percentage)	90.0% (5.1)	91.2% (5.2)	90.5% (5.0)
Actual dose (responses)	85.3 (18.8)	79.5 (20.4)	66.5 (25.8)
Session length (minutes)	28.6 (3.0)	28.5 (3.3)	28.0 (3.2)
Time 2: Completed after 12th session			
Dose form accuracy (percentage)	94.4% (3.7)	95.8% (3.9)	
Actual dose (responses)	79.8 (16.3)	79.5 (17.7)	
Session length (minutes)	28.3 (2.3)	28.8 (0.8)	

Note. Parentheses indicate *SD*s.

Table 4. Mean performance on pretest measures of oral motor, receptive language, and phonological skills, by condition.

Pretest	P1 (n = 19)	P3 (n = 19)	C (n = 16)
Oral motor skills raw score	80.8 (6.9)	85.2 (5.5)	83.1 (7.5)
TELD–3 Receptive standard score	90.3 (15.4)	102.4 (21.0)	96.2 (21.2)
GFTA–2 standard score	71.2 (17.1)	70.5 (15.5)	70.5 (14.8)
KLPA–2 standard score	67.5 (17.0)	68.5 (16.4)	67.1 (18.5)
PCC	54.8% (18.3)	52.4% (19.0)	54.8% (18.1)
Phonemes in collapse	7.1 (4.3)	7.8 (5.0)	
Intervention targets	2.8 (0.6)	2.8 (0.9)	

Note. TELD–3 = Test of Early Language Development, Third Edition; GFTA–2 = Goldman Fristoe Test of Articulation—Second Edition; KLPA–2 = Khan–Lewis Phonological Analysis—Second Edition; PCC = percentage of consonants correct.

Follow-up pairwise comparisons were not completed due to the lack of significance. The results are presented in Table 4.

Effect of Frequency After 8 Weeks

The first research question addressed the impact of a phonological intervention provided three times per week versus one time per week after 8 weeks. The evaluation of the homogeneity-of-slopes assumption was nonsignificant for Group × Initial PCC, $F(2, 45) = 1.33$, $p = .28$, partial $\eta^2 = .06$, and receptive language, $F(2, 45) = 1.15$, $p = .33$, partial $\eta^2 = .05$. The ANCOVA was significant, $F(2, 49) = 4.15$, $p = .02$, partial $\eta^2 = .15$. Follow-up pairwise comparisons indicated that the P3 condition had the largest adjusted mean (M = 65.0%), followed by the P1 (M = 60.1%) and C (M = 58.6%) conditions. The P3 condition performed significantly better than the P1 ($p = .037$) and C ($p = .009$) conditions, as reported in Table 5. There was no significant difference between the P1 and C conditions ($p = .53$). The effect size was medium between the P3 and P1 conditions ($d = 0.72$) and was large between the P3 and C conditions ($d = 0.95$).

Effect of Frequency After 24 Sessions

The second research question addressed the impact of a phonological intervention provided three times per week versus one time per week after 24 sessions. Only the P1 and P3 conditions were provided 24 sessions. The evaluation of the homogeneity-of-slopes assumption was nonsignificant for Group × Initial PCC, $F(1, 32) = 0.67$, $p = .42$, partial $\eta^2 = .02$, and receptive language, $F(1, 32) = 0.99$, $p = .33$, partial $\eta^2 = .03$. The ANCOVA was significant, $F(1, 34) = 4.16$, $p = .049$, partial $\eta^2 = .11$. The P3 condition's adjusted mean (M = 63.7%) was significantly larger than the P1 condition's adjusted mean (M = 59.3%), as reported in Table 5. The effect size was medium between the P3 and P1 conditions ($d = 0.69$). There was a change in the adjusted mean for the P3 group from the 8-week posttest to the 24-session posttest, even though this was the same data point due to a change in the groups included in the analysis.

Table 5. Adjusted mean performance on posttest measures of phonological skills, by condition.

Posttest measure	P1 (n = 19)	P3 (n = 19)	C (n = 16)
Eight weeks of intervention			
Adjusted mean PCC[a,b]	60.1% (1.6)	65.0% (1.6)	58.6% (1.7)
Twenty-four sessions of intervention			
Adjusted mean PCC[a]	59.3% (1.5)	63.7% (1.5)	

Note. Adjusted mean = controls for initial PCC and receptive language. *SD*s appear in parentheses.

[a]P3 and P1 comparison significant at $p < .05$. [b]P3 and C comparison significant at $p < .05$.

Effect of Frequency After a 6-Week Maintenance Period

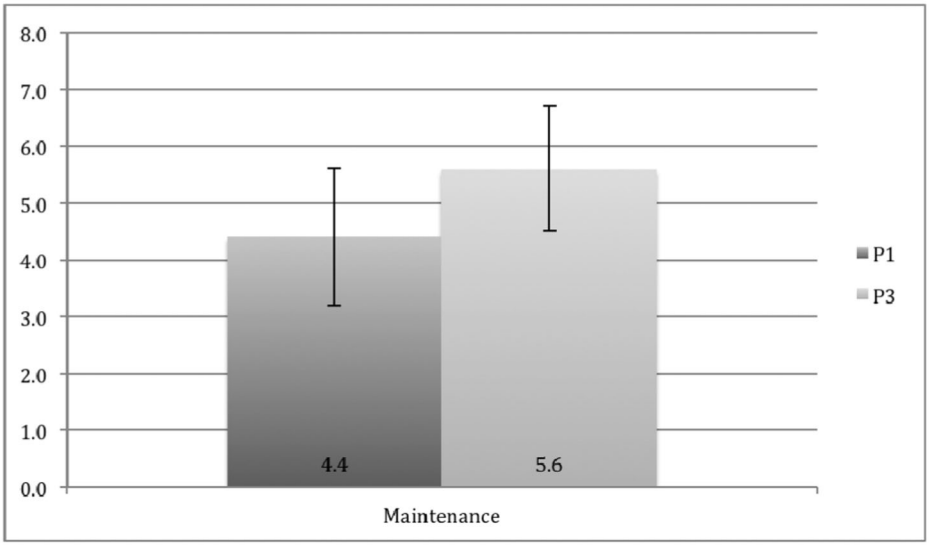
The third research question addressed the impact of a phonological intervention provided three times per week versus one time per week during a 6-week maintenance period. Only the P1 and P3 conditions were provided a maintenance period. A one-sample t test was conducted on the gain in PCC from the posttest after 24 sessions to the end of the 6-week maintenance period for each condition to evaluate whether the mean was significantly different from 0. The means for the P1 (M = 3.8, SD = 3.4) and P3 (M = 5.8, SD = 6.0) conditions were significantly different from 0, $t(15) = 4.37$, $p = .001$, and $t(18) = 4.22$, $p = .001$, respectively. Because both conditions made gains significantly different from 0, an ANCOVA was completed. The evaluation of the homogeneity-of-slopes assumption was nonsignificant for Group × Initial PCC, $F(1, 29) = 2.40$, $p = .13$, partial $\eta^2 = .08$, and receptive language, $F(1, 29) = 0.27$, $p = .61$, partial $\eta^2 = .01$. The ANCOVA was not significant, $F(1, 31) = 0.27$, $p = .61$, partial $\eta^2 = .009$. The adjusted mean gain for the P1 (n = 16, M = 4.4, SE = 1.2) and P3 (n = 19, M = 5.6, SE = 1.1) conditions are reported in Figure 2.

Discussion

Effect of Frequency After 8 Weeks

The primary conclusion for the first research question was that preschool children who received the multiple oppositions approach three times per week significantly outperformed preschool children who received the same

Figure 2. The adjusted mean gain in percentage of consonants correct (PCC), controlled for initial PCC and receptive language, after 6 weeks of maintenance for the P1 and P3 conditions. Error bars indicate standard errors.



approach one time per week for only 8 weeks. This finding is consistent with Schooling et al.'s (2010) systematic review and provides additional evidence to support the idea that more intensive intervention brings about a better outcome. A surprising finding was that only the P3 condition significantly outperformed the C condition, because the hypothesis was that both phonological intervention conditions would outperform the C condition. The lack of significant differences between the P1 and C conditions may have been due to maturation, learning how to learn, or the storybook intervention inadvertently improving phonological skills. The summary of responses in the Appendix indicates that physical/linguistic pointing was the primary response mode, but it is possible that the letter-naming activity, which was provided only once, may have impacted phonological productions.

Effect of Frequency After 24 Sessions

The principal finding for the second research question was that preschool children who received the multiple oppositions approach three times per week significantly outperformed preschool children who received the same approach one time per week after 24 sessions. The intervention protocol intended for children in the P1 and P3 conditions to receive the same dose, although actual dose means were slightly different (see Table 3). Differences in dose means, which resulted in differences in cumulative intervention intensity, were not statistically significant and lend support to the idea that dose frequency was the intensity variable accounting for the different outcomes. The effect after 24 sessions was slightly smaller than the one after 8 weeks of intervention; nevertheless, a medium effect size was still produced. This finding is in contrast with Page et al. (1994), who found no significant difference for phonological outcomes when preschool children were provided an intervention either three times per week for 2 weeks or one time per week for 6 weeks. These different findings may indicate that a duration of six sessions is enough to significantly impact phonological skills, but a greater total intervention duration—for example, 24 sessions—is needed to demonstrate an intensity effect.

Maintenance of Phonological Skills

Children in both intervention conditions improved their phonological skills during the maintenance period, although there was no significant difference in gain for the two conditions. The finding that children continued to improve their speech during a maintenance period is different from Page et al. (1994), who found that the children made no gains during the maintenance period. The difference in these findings may be due to the different intervention approach or the total number of sessions. The multiple oppositions approach, based on the maximal distinction and maximal classification principles, may have stimulated the phonological systems to a greater extent than the intervention utilized by Page et al. (1994), which targeted individual phonological patterns. Another possibility is that six sessions do not provide enough intervention to stimulate a phonological system so that it will continue to mature during a maintenance period. The results of the maintenance period indicate the importance of continuing intervention for children with SSD until a dismissal criterion has been met.

Clinical Implications

Weekly session frequency should be considered by SLPs using the multiple oppositions approach with preschool

children with SSD. Individuals searching for research supporting more intensive dose frequency should note that these findings are only associated with the multiple oppositions approach when implemented with preschool children; however, this is an important first step in determining the optimum intervention intensity for this intervention approach. The current study would need to be replicated with other phonological intervention approaches to determine if, in fact, this finding can be generalized. Nevertheless, the results of this study are likely to be of interest to SLPs in the midst of determining dose frequency.

In addition, the current study contributes higher-level evidence to the current evidence base regarding the efficacy of the multiple oppositions approach (Pagliarin et al., 2009; Williams, 2000a, 2000b, 2005) due to the completion of a larger scale, randomized controlled study. In addition, the present study presents evidence for intervention effectiveness as it was implemented by seven SLPs and two SLPAs in their natural work settings with a high level of fidelity.

Study Limitations and Future Directions

Limitations center around the challenges of controlling the intervention intensity variables. Dose form was the easiest variable to control due to the intervention protocol. The fidelity-of-implementation data indicate that dose form was implemented with a high level of fidelity. Total intervention duration was intended to be 24 sessions—although, in actuality, it averaged 19.42 sessions for the P1 condition and 19.84 sessions for the P3 condition. Dose frequency was designed to compare a one-time-per-week intervention to a three-times-per-week intervention. The attendance data indicate that the expected ratio of one to three sessions every week was not achieved, although the actual ratio of 0.81 to 2.48 sessions per week did show significant effects.

The most difficult aspect to control was dose. Training and the intervention protocol provided an intended dose, but there was variability reported in the fidelity-of-implementation data, requiring multiple feedback sessions to better control this intervention intensity variable. It is possible that the prescribed minimum dose, 81, was too high. In addition, there may have been a difference in the number of targets and, thus, the number of times each target was addressed. For example, a child with one to two targets would have had more opportunities to produce those targets, resulting in deeper training. In contrast, a child with three to four targets would have had fewer opportunities to produce each target, resulting in broader training. In order to better control dose for the multiple oppositions approach, all children would need to have the same number of targets, and this is worthy of future investigations. These data do provide preliminary evidence that dose should be explicitly stated in a Method section and captured in fidelity-of-implementation data.

A second potential limitation was the use of the multiple oppositions approach for all children. The multiple oppositions approach was chosen for all participants due to the need for a consistent intervention protocol. This phonological intervention has been recommended for children with severe and moderate–severe SSD (Pagliarin et al., 2009), so it is possible that the children with mild–moderate SSD may not have benefited from this approach as much as from a different phonological intervention approach.

A third potential limitation is the possible confound of concomitant speech and language impairment. In the current study, only receptive language was assessed. The differences between the P1 and P3 conditions were not significantly different, although the mean 10-point difference could indicate subtle differences in broad receptive language skills. Different profiles of children with SSD may include those with receptive and expressive language impairment, receptive language impairment only, expressive language impairment only, and no language impairment. It has been noted that poorer comprehension skills may have a negative impact upon prognosis (Paul, 2007), so it is possible that these different profiles of children with concomitant speech and language impairment may present with different responsiveness rates to phonological intervention.

In the future, a larger speech sample should be collected because it may be a more sensitive outcome measure for analyzing PCC. Although the GFTA–2 samples all initial singleton consonants, very few consonants are sampled more than once. In addition, a minimal number of consonant clusters are sampled. A measure that elicited each singleton consonant in initial and final positions of words as well as consonant clusters at least five times each may have provided a more sensitive phonological outcome measure. A different option for a possibly more sensitive outcome measure would be a score based on the Scaffolding Scale of Stimulability (Glaspey & Stoel-Gammon, 2005).

This study provides an initial investigation into the manipulation of one intervention intensity variable for one phonological intervention approach. The manipulation of other intervention intensity variables—for example, dose—would inform the field of the best combination of intervention intensity variables for each intervention approach. In addition, homework may increase intensity by providing additional doses to cumulative intervention intensity. Once the best combination of intervention intensity variables is known across phonological intervention approaches, then interventions can be validly compared to determine which are most effective and efficient.

Conclusion

The quest to investigate the effect of intervention intensity variables upon phonological outcomes continues to be an area of need within the communication disorders literature. Results from the current study indicate that preschool children with SSD receiving the multiple oppositions approach made significantly greater gains in intervention when they were provided with a more intensive, three-times-per-week dose frequency than when cumulative intervention intensity was held constant. The children receiving a one-time-per-week intervention dose frequency also made progress, but the growth was similar to that of the children in an active control condition. Future examination of the impact of dose frequency upon phonological outcomes

is warranted to determine if preschool children differentially respond to variations in frequency no matter the chosen phonological intervention approach.

Acknowledgments

This research project was completed with the support of a research grant awarded by the University of Wyoming Faculty Grant-in-Aid. I would like to thank Teresa Ukrainetz and Sue Torney for comments and suggestions regarding the design and implementation of this project as well as Amber Abel, April Amonson, Anne Marie Austin, Carissa Lee, and Erin McDonald for their research assistance. I would also like to thank the STRIDE Learning Center, its personnel, and the many children and parents associated with the center for their continued research support.

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Appendix

Active Control Intervention Targets

Instructional domain	Target	Response
Book and print organization	Page order: Order in which pages are read	Pointing
	Author: Finding who wrote the book	Pointing
	Page organization: Reading top to bottom	Pointing
	Title of book: Finding the name of the book	Pointing
	Print direction: Reading left to right	Pointing
Print meaning	Print function: Relationship between print and meaning	Pointing, imitation, oral
	Environmental print: Purpose of print in environment	Pointing
	Metalinguistic concept of reading: Purpose of reading	Pointing, imitation, oral
Letters	Upper- vs. lowercase letters: Recognizing differences	Pointing
	Names of letters: Letter identification	Pointing, imitation, oral
	Metalinguistic concept of letter: Letters as symbols	Pointing
Words	Word identification: High-frequency word recognition	Pointing, imitation
	Short vs. long words: Recognizing differences	Pointing
	Letters vs. words: Recognizing differences	Pointing
	Concept of word in print: Meaning behind reading	Pointing

Note. Pointing = physical gestures and linguistic markers (e.g., *right here, this one*); imitation = oral response identical to interventionist; oral = independent oral response of the target. This intervention is based on Project STAR: Sit Together and Read (Justice, Kaderavek, Fan, Sofka, & Hunt, 2009).