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COMMENTARY

Intensity in phonological intervention: Is there a prescribed amount?

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Abstract
Despite a number of studies that have demonstrated positive outcomes for inducing clinical change in children with speech sound disorders (SSD), there is a need to address the question of whether resources are being applied in an optimal manner. As a consequence, there has been a call to look within interventions to examine parameters that may contribute to intervention outcomes; specifically the intensity of intervention (dose, frequency, duration, and cumulative intervention intensity). In this paper, empirical evidence from three intervention studies using multiple oppositions primarily, and a second contrastive approach, minimal pairs, is reported with regard to the parameters of intervention intensity. The findings indicated that greater intensity yields greater treatment outcomes. Further, quantitative and qualitative changes in intensity occur as intervention progresses, and there were differences in intensity based on severity of the SSD. Based on these data, suggestions were made toward establishing some prescribed amounts of intensity to affect treatment outcomes for children with SSD.

Keywords: *Intensity, dose, multiple oppositions, speech sound disorders, phonology.*

Introduction

There are a number of intervention options available to speech-language pathologists (SLP) which have been shown to be effective in remediating speech sound disorders (SSD) in children (Baker & McLeod, 2011; Gierut, 1998; Kamhi, 2006; Law, Garrett, & Nye, 2004). Despite the number of studies that have demonstrated positive outcomes for inducing clinical change in children with SSD, there is a need for research to look within interventions to examine parameters that may contribute to intervention outcomes. As the focus of this forum suggests, other factors, such as intensity of intervention, may contribute to treatment outcomes beyond the intervention approach. In the lead article, Baker (2012) clearly summarized the five concepts of intervention intensity that Warren, Fey, and Yoder (2007) described (i.e., dose form, dose, dose frequency, total intervention duration, and cumulative intervention intensity). She broke down intensity into SLP inputs and client acts (i.e., output) as part of a proposed framework to measure the combined contributions of input + output in calculating intervention intensity. In this response, intensity will be examined in one specific dose form of phonological intervention, namely multiple oppositions (MO) (Williams, 2000a, b, 2010), and secondarily within another contrastive approach, minimal pairs (e.g., Weiner, 1981). Treatment data sheets and daily therapy logs were examined to calculate dose, frequency, and duration across three separate intervention studies. These parameters will be summarized with regard to the client output and used to calculate the cumulative intervention intensity within each study. Finally, each of these components will be drilled down further in order to identify potential qualitative and/or quantitative factors that may lead to a prescribed dosage.

Multiple oppositions intervention approach

Overview of approach

The multiple oppositions approach (Williams, 2000a, b, 2005, 2006a, 2010) is directed at reducing and eliminating homonymy that results from a one-to-many correspondence between the smaller child sound system relative to the adult sound system. Intervention is directed at up to four target sounds selected from across a rule set, or phoneme collapse, based on a distance metric for selecting diverse targets across place, voice, and manner. Larger treatment sets of contrastive word pairs are presented to the child in order to enlarge the child's frame of learning that is required to induce multiple phonemic splits. A treatment paradigm (Williams, 2000b, 2003, 2010) was described for implementing the multiple oppositions approach that describes a suggested dose. There are three phases to intervention: Phase I involves familiarization of the rule, sounds, and vocabulary of

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the treatment exemplars and lasts for one session. Phases II and III are data-based with specified criteria for matriculation from imitative to spontaneous response levels (Phase II; 70% accuracy across two consecutive treatment sets) and from focused practice with naturalistic "bridging" activities to production of the contrasts within communicative contexts (Phase III; 90% accuracy across two consecutive treatment sets). Suggested dose frequency is a minimum of 60 responses during focused practice and 20 responses during naturalistic activities within a 30-minute individual session.

Intervention studies included for intensity investigation

Three studies were included in examining intervention intensity variables. Each study incorporated the Phases within the treatment paradigm. In addition, all participants met the same inclusionary criteria, which included the following: (1) at or below the 25th percentile on the Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 1986); (2) normal hearing, as determined by a standard audiometric screening (ASHA, 1985); (3) no known history of organic or motor disorders, as determined by an oral mechanism examination and a case history; (4) normal intelligence, as determined by a standard score of at least 85 on the Peabody Picture Vocabulary Test-III (Dunn & Dunn, 1997); (5) between the ages of 42–78 months; and (6) reside in a monolingual English-speaking family. Additionally, all studies incorporated 30-minute individual sessions twice weekly (dose frequency) and a maximum number of 21 treatment sessions per behaviour or treatment condition (total intervention duration).

Pre- and post-intervention phonological analyses were completed for each child across the three studies using the Systemic Phonological Protocol (SPP; Williams, 2003), which is an extensive 245 single-word elicited sample. Based on this sample, each child's sound system was described in terms of phonetic inventory, distribution, phonotactic constraints, phonological rules, and phoneme collapses (Williams, 1993, 2003), and the percentage of correct underlying representations (PCUR) relative to the ambient sound system was computed. PCUR represents the proportion of the child's sound system that is "known" relative to the adult sound system (Gierut, Elbert, & Dinnsen, 1987; Williams, 1991, 1993).

Intervention intensity: Dose, duration, and total cumulative intervention intensity

Study 1: Multiple oppositions (MO) study. An intervention efficacy study of the MO approach was conducted with 14 children (four girls and 10 boys) who ranged in age from 4 years; 0 months to 6 years; 0 months (mean age = 4 years; 9 months) and exhibited moderate-to-severe SSD. A combined multiple baseline across behaviours and across subjects experimental design was used to treat two different multiple opposition rule sets for each child. Each child received a maximum of 21 half-hourly treatment sessions for each rule set, or less if they met the generalization criterion of 50% accuracy of the targeted sounds in a connected speech sample. Thus, a maximum of 42 30-minute intervention sessions could be completed by a child.

Table I summarizes the number of trials and average number of trials (dose) for each behaviour, the number of sessions completed for each behaviour (duration), and the total cumulative intervention intensity for each of the 14 children. As shown, the average number of trials for Behaviour 1 was 70.61 (range: 56.64–105.55) completed in an average of 20 sessions (range: 14–21), while the dose was slightly lower for Behaviour 2 (61.09 trials [range:

Table I. Intervention intensity and treatment outcomes: Multiple oppositions (MO) study.

Participant (pre-tx severity)	Behaviour 1		Behaviour 2						
	# trials (ave)	# sessions	# trials (ave)	# sessions	Total trials	Ave	PCUR1	PCUR2	Δ
TC (profound)	1345 (64.04)	21	1290 (61.43)	20	2635	64.27	24	52	+ 28
CD (moderate)	1249 (62.45)	20	160 (40)	4	1409	58.71	58	90	+ 32
CT (moderate)	793 (56.64)	14	904 (43.05)	20	1697	49.91	51	63	+ 12
BS (severe)	2111 (105.55)	21	360 (30)	13	2471	72.68	34	97	+ 63
MH (moderate)	1043 (61.35)	17	361 (120.33)	3	1404	70.2	63	76	+ 13
JV (moderate)	981 (49.05)	20	765 (51.0)	15	1746	49.89	71	83	+ 12
HS (profound)	2048 (97.52)	21	1750 (83.33)	21	3798	90.43	13	66	+ 53
JT (severe)	1498 (71.33)	21	680 (32.38)	21	2178	51.86	43	87	+ 44
BB (severe)	1728 (82.28)	21	1437 (68.43)	21	3165	75.36	31	55	+ 24
FG (profound)	1595 (75.95)	21	1555 (74.05)	21	3150	75.0	19	64	+ 45
SS (severe)	1513 (72.05)	21	1686 (80.29)	21	3199	76.17	34	51	+ 17
JS (profound)	1616 (76.95)	21	917 (43.67)	21	2533	60.31	28	92	+ 64
TM (profound)	1158 (55.14)	21	870 (41.43)	21	2028	48.29	28	34	+ 6
CE (severe)	1167 (58.35)	20	1802 (85.81)	21	2969	72.42	34	71	+ 37
Average [SD]	70.61 [16.16]	20 [2.03]	61.09 [25.65]	17.36 [6.38]	2455.59 [743.29]	65.39 [12.67]	37.93 [17.06]	70.07 [18.42]	+ 32.1 [19.42]

PCUR, Percentage of correct underlying representations.

30–85.81] completed in an average of ~17 sessions [range: 3–21]). Cumulatively, an average of 2455.59 trials was completed in ~34 sessions (33.93) for an average total number of trials/session of 65.39 across both behaviours.

Linking these intensity data with treatment outcomes will provide some information regarding effective dosage. The final three columns in Table I report the PCUR on the pre- and post-treatment phonological analyses, as well as the change in PCUR from pre- to post-treatment. As shown, improvement was observed with each child with regard to gains in PCUR. The range of improvement was 6–64, with an average change of + 32.1 in PCUR that occurred in ~34 treatment sessions.

Study 2: Multiple oppositions-Minimal pairs (MP) study. This investigation involved a comparative intervention study of the multiple oppositions approach and minimal pairs with four children (three females; one male) with moderate-to-severe SSD. They ranged in age from 4 years; 6 months to 6 years; 5 months, with a mean age of 5 years; 3 months. A multiple baseline across behaviours experimental design was implemented to treat one multiple oppositions goal and a comparable number of sound targets within a minimal pairs approach. Similar to Study 1, each treatment condition received a maximum of 21 30-minute sessions for a total possible 42 sessions across the two treatment conditions.

Table II reports the dose (total and average number of trials/child) and frequency (number of sessions) for each of the two treatment conditions (MO and MP), as well as the cumulative number of trials across both conditions. To equate the number of sounds addressed in intervention between the two approaches, more than one error pattern (training broad), such as final consonant deletion, fronting, and stopping; or more than one target from a single error pattern (training deep), such as /f, s, ʃ/, was addressed in minimal pairs. Intensity is examined first with regard to specific treatment condition. The dose was slightly higher in the MO condition with an average of 82.25 trials/session (range 52.38–149.14) in an average of 17.5 sessions (out of a maximum of 21 sessions). For the MP condition, an average of 71.91 trials/session (range 61.90–81.90) occurred in an average of 17 sessions. Overall across both conditions, the cumulative intervention intensity was 2499.25 (average of 78.99 trials/session) for an average of 35 total sessions (out of possible 42 sessions). Regardless of condition, the intensity was comparable to that provided in Study 1. Looking at treatment outcomes in terms of change in PCUR, again a positive gain was obtained for each child. The average pre-treatment PCUR was 58.5 and the post-treatment PCUR was 84.0, which is a gain of 25.5. The improvement was less than for Study 1, but the initial PCUR was much higher (58.5 compared to 37.93), so there was less room for improvement.

Study 3: Computer-based intervention (CBI): Table top intervention (TTI) study. This investigation involved a brief comparative intervention of computer-based intervention (CBI) using the Sound Contrasts in Phonology (SCIP) software program (Williams, 2006b) and traditional table-top intervention (TTI) using the contrastive minimal pairs approach. Four kindergarten children with moderate-to-severe SSD (three males; one female ranging in age from 3;7–4;9 with mean age of 4;3) participated in both treatment conditions. Although the multiple oppositions approach was not employed in this study, a similar treatment paradigm was utilized. The exception was a lower criterion to complete each treatment condition: specifically, treatment continued until the child's performance was 50% higher than their baseline mean for the target sound. This resulted in fewer treatment sessions within each condition.

A summary of the dose, frequency, and cumulative intervention intensity is provided in Table III. As noted previously, the criterion to change from one condition to the other was different than the previous two studies and only required the child to achieve 50% accuracy above their baseline mean on the target sound. As a consequence, children completed training in much fewer sessions. Across both treatment conditions, the average number of trials and sessions was 51.56 trials in 9.75 sessions. There was little difference in dose or frequency within the two treatment conditions of Study 3. Specifically, the average number of trials and sessions for the CBI condition was 48.63 trials in 4.5 sessions compared to 46.73 trials in 5.25 sessions for the TTI condition. However, total dose and frequency across

Table II. Intervention intensity and treatment outcomes: Multiple oppositions-Minimal pairs (MO-MP) study.

Child (pre-tx severity)	Condition	# trials (ave)	# sessions	Condition	# trials (ave)	# sessions	Total trials	Ave	PCUR1	PCUR2	Δ
AS (severe)	MO	1044 (149.14)	7	MP	320 (64.0)	5	1364	113.67	37	94	+ 57
ST (moderate)	MO	1100 (52.38)	21	MP	1720 (81.90)	21	2820	67.14	70	78	+ 8
LC (moderate)	MO	1505 (71.67)	21	MP	1300 (61.90)	21	2805	66.79	57	83	+ 26
TG (moderate)	MP	1836 (79.83)	23	MO	1172 (55.80)	21	3008	68.36	70	81	+ 11
Average [SD]	MO	82.25 [42.19]	17.5 [7]	MP	71.91 [10.41]	17 [8]	2499.25 [762.44]	78.99 [23.12]	58.5 [15.58]	84.0 [6.97]	25.5 [22.42]

PCUR, Percentage of correct underlying representations; MO, Multiple oppositions; MP, Minimal pairs.

Table III. Intervention intensity and treatment outcomes: Computer-based intervention-Table top intervention (CBI-TTI) study.

Child (pre-tx severity)	Condition	# trials (ave)	# sessions	Condition	# trials (ave)	# sessions	Total trials	Ave	PCUR1	PCUR2	Δ
HS (moderate)	CBI	430 (53.75)	8	TTI	76 (38)	2	506	50.6	59	62	+3
JO (severe)	TTI	116 (38.67)	3	CBI	70 (35)	2	186	37.2	49	60	+11
BE (moderate)	CBI	282 (70.50)	4	TTI	129 (43)	3	411	58.71	63	58	−5
IH (severe)	TTI	874 (67.23)	13	CBI	141 (35.25)	4	1015	59.71	37	40	+3
Average [SD]	CBI	48.63 [17.02]	4.5 [2.51]	TTI	46.73 [13.84]	5.25 [5.18]	529.5 [350.37]	51.56 [10.40]	52 [11.60]	55 [10.13]	3 [6.53]

PCUR, Percentage of correct underlying representations; MO, Multiple oppositions; MP, Minimal pairs; CBI, Computer-based intervention; TTI, Table top intervention.

both conditions are substantially lower than either Study 1 (65.39 trials in 33.93 sessions) or Study 2 (78.99 trials in 35 sessions). It is not surprising, then, that the treatment outcomes were much smaller in Study 3 than in the previous two studies. Across the four children, an average PCUR change of 4 was obtained (as compared to 32.14 and 25.5 in Study 1 and 2, respectively). Further, not all children evidenced gains in PCUR following intervention. Notice that child BE actually had a lower post-treatment PCUR.

Factors influencing intervention intensity

Collectively, the data across the three studies indicate that intensity matters. A comparison of the average dose (trials), average duration (sessions), and average gain in PCUR for each of the three intervention studies is provided in Figure 1. From these data, it seems that a dose greater than 50 trials per session and for ~ 35 sessions is needed to evidence substantial treatment gains. Less intensity resulted in limited treatment outcomes. However, does intensity change over the course of intervention? Do children with more severe SSD require greater intensity than children with less severe SSD? To address these questions, closer examination of the 14 children in Study 1 was completed.

With regard to intensity changes over time, dose was tabulated for the first half of the treatment sessions (1–11 for 21 sessions) and compared to the dose for the second half of the treatment sessions (12–21) for each of the two behaviours that were trained with multiple oppositions. Figure 2 represents the average total dose that was completed within intervention for one phonological goal as compared to the dose completed in the first half of the intervention vs the second half of intervention. Looking only at the number of trials completed across the 14 children (the bar height), the dose for the first half of treatment on a specific goal averaged to 716.21 trials as compared to 590.33 trials for the second half of treatment on the same goal. This implies that there is greater intensity as the child is learning a new sound contrast; ~20% greater intensity in the first half of intervention, which is lessened as the child progresses on a specific goal.

In addition to this quantitative difference over time for a single goal, is there a qualitative difference in the type of trials completed in the session? Recall that Phase II of the treatment paradigm included focused practice of the contrastive word pairs followed by a brief naturalistic play activity. The naturalistic play provides a "bridging" activity in which the child has an opportunity to practice the targets within "sound flooded" activities that incorporate a high proportional frequency of the target sound in more natural interactive play. To answer this question, the total number of trials of focused practice of the contrasts was calculated from the total number of trials completed during the naturalistic play activities for each goal. Refer again to Figure 2, which shows the number of focused practice trials and number of naturalistic play trials within the

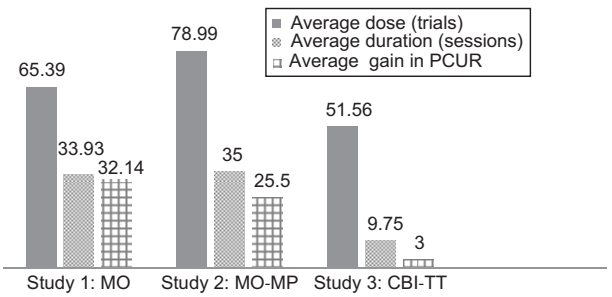

Figure 1. Comparison of average intensity (dose and duration) and treatment outcomes across three studies. MO, Multiple oppositions; MP, Minimal pairs; CBI, Computer-based intervention; TT, Table top; PCUR, Percentage of correct underlying representations.

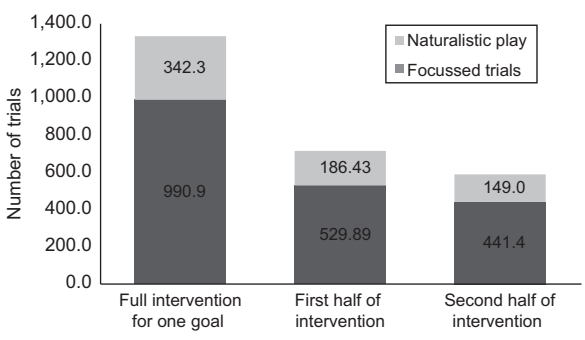

Figure 2. Comparison of quantitative and qualitative differences in dose across a full intervention period and the first and second half of intervention.

total number of trials for the full intervention vs the first and second half of intervention. This is represented by the shading within each bar on the graph. The average total number of focused practice trials was 990.89 compared to the average of 342.29 trials produced during naturalistic activities. Thus, the type of trials completed is comprised primarily of focused practice with an average of 34.5% of the trials reflecting practice of the targets during naturalistic play; about a 2:1 ratio of focused practice to naturalistic practice. This ratio was maintained throughout the length of time to complete training on a specific goal. That is, in the first half of intervention on a specific goal, naturalistic play practice comprised 35.18% and for the second half of intervention it was 33.75%.

With regard to severity, further examination of the treatment outcomes for the 14 children in Study 1 revealed high and low outcome groups. The high outcome group included 10 children whose PCUR-2 increased by 50% or more from their PCUR-1 following intervention. Specifically, the average gain in PCUR for these 10 children was + 40.7 as compared to + 10.75 for the four children in the low outcome group. Table IV compares the average number of trials (dose), sessions (duration), and change in PCUR for these two groups of children. As shown in this table, the high outcome group had higher intensity (average dose of 69.72 and duration of 39.2 of a possible 42 sessions) compared to the low outcome group (average dose of 54.57 and duration of 32.75). Williams (2000b) related PCUR values to severity of involvement categories. When we examine the pre-treatment PCUR of these children, the high outcome group fell into the severe range with an average PCUR-1 of 31.8 compared to a moderate severity for the low outcome group (average PCUR-1 of 53.25). Thus, children with greater severity required higher intensity and achieved greater treatment outcomes.

Taken together, it appears that the following can be summarized from the intensity data across these three studies:

1) A minimum dose of more than 50 trials and duration of at least 30 sessions is required for a phonological intervention to be effective. A dose below 50 trials in a 30 minute session and fewer than 30 sessions appears to have limited effectiveness.
2) For children with a more severe SSD, greater intensity is required to effect change. For these children, the suggested dose is 70 trials per session for ~ 40 sessions.
3) There are both quantitative and qualitative changes in dose over the course of intervention for a specific goal. Specifically, greater intensity occurs at the beginning of intervention and tapers off ~ 20% for the second half of intervention on a particular goal. Qualitatively, a combination of focused practice and naturalistic play activities was incorporated at about a 2:1 ratio throughout intervention. The bridging activities are incorporated to program for generalization (Culatta & Horn, 1982).

Discussion

As Baker (2012) noted in her conclusion, more research is needed to investigate the effect of manipulating the various components of intensity on treatment outcomes. Fortunately, some of that work has already begun in the area of SSD. In a systematic review, Schooling, Vendiktov, and Leech (2010) investigated the effects of frequency, intensity, or duration on the speech and language skills of preschool children. Although 28 of the 35 calculated effect sizes were non-significant, six of the seven significant effect sizes were found with regard to more frequent, intense, or longer interventions. One aspect of intervention intensity that has recently been examined is the effect of concentrated vs dispersed schedules of intervention. Allen (in press) reported results from a randomized control study with 54 children with SSD assigned to one of three treatment conditions using multiple oppositions: (1) MO 3-times per week for 8 weeks; (2) MO once weekly for 24 weeks; and (3) control condition involving a storybook intervention. She found that the concentrated intervention schedule had significantly better outcomes than the dispersed and control conditions, but there were no significant differences between the once weekly dispersed schedule and control condition. These findings suggest that the schedule of intervention is an important variable to consider and potentially supports an intervention schedule of blocks and breaks, as described by Bowen (2010).

In sum, the issue of intervention intensity begs us to ask the question, "Are we applying our resources in the most optimal way?" We have some preliminary answers to that question primarily with regard to client acts, although it is an important aspect of our interventions which we need to continue to consider in our clinical service to children with SSD.

Table IV. Comparison of intervention intensity for high and low treatment outcome groups.

	High outcome group (PCUR gains ≥ 50%)	Low outcome group (PCUR gains < 50%)
Average dose (trials)	69.72	54.57
Average duration (sessions)	39.2	32.7
Average PCUR pre-treatment	31.8 (severe)	53.2 (moderate)

PCUR, Percentage of correct underlying representations.

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