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Article

Word-Finding Intervention for Children With Specific Language Impairment: A Multiple Single-Case Study

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Purpose: This study examined the effectiveness of a combined phonological and semantic intervention for children with specific language impairment who had word-finding difficulties (WFDs).
Method: To evaluate the intervention, a multiple single-case design was implemented with 4 children, ages 9;6 (years;months) to 13;9, who had WFDs. Some items were trained using a phonological intervention; others were trained using a semantic one. Lexical access outcomes were measured using a picture-naming test at pre- and posttesting.
Results: Three children exhibited a significant reduction in WFDs on the intervention words after 6 sessions. These effects were present at posttest and 6 months later for the treated words only and not the control words. Each child responded differently to the intervention, and these response patterns seemed to be related to each child's linguistic profile.
Conclusion: This intervention seemed to achieve long-lasting reductions in children's WFDs. The differential responses to phonological and semantic intervention imply the need to tailor intervention for differing children by matching it to their linguistic profile.

Key Words: word-finding difficulties, intervention efficiency, SLI, lexical access

Interventions for word-finding difficulties (WFDs) for children with specific language impairment (SLI) usually focus on semantics or phonology, separately or together. These interventions reflect hypotheses that impaired underlying semantic and/or phonological representations cause WFDs. This study aims to enrich the understanding of causes of WFDs by considering how children with different linguistic profiles respond to an intervention that combines phonology and semantics.

Intervention focusing on semantics (semantic intervention) assumes that WFDs reflect inadequate or underspecified *semantic representations*. Semantic intervention aims to enhance one's knowledge of specific word attributes in order to strengthen the corresponding semantic representation. For example, activities to enrich the concept of a *banana* may focus on developing children's knowledge about the banana's attributes, such as its appearance and function. Semantic intervention may also aim to increase interconnections between vocabulary items by developing children's knowledge of synonymy, antonomy, and hyponomy; that is, words of similar and opposite meanings, and how words interrelate, respectively. Such intervention simultaneously develops participants' self-cuing skills (Wing, 1990; Wittman, 1996) as participants can name these attributes while retrieving the target word. For example, when a child cannot name a cherry, he or she can self-cue by saying, *It's round, it's red, it is a fruit; I've got some in my garden.... Oh yes, it's a cherry.*

Four sources of evidence support the use of semantic intervention with children with WFDs. First, children with WFDs are slower and less accurate in naming than their typically developing (TD) peers are and frequently use semantic substitutions (Dockrell, Messer, & George, 2001). Second, the word definitions of children with WFDs are less precise and contain fewer information units and more redundant information than those of their TD peers (Dockrell, Messer, George, & Ralli, 2003). Third, children with WFDs include less information when drawing pictures of words than their TD peers do (McGregor & Appel, 2002; McGregor, Newman, Reilly, & Capone, 2002). Finally, semantic

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intervention that aims to enhance semantic representations decreases children's response time latency in naming pictures (Bragard & Maillart, 2005).

Intervention focusing on phonology (phonological intervention) assumes that WFDs reflect inadequate or underspecified *phonological representations* of words. Phonological intervention aims to enhance and fortify the underlying representation by improving children's phonological awareness or teaching self-cuing through metalinguistic tasks, such as recalling the first sound of the target word (Wing, 1990; Wittman, 1996; Wright, 1993). Two sources of evidence support the use of phonological intervention with children with WFDs. First, children with WFDs fail phonological tasks but not semantic ones (Constable, Stackhouse, & Wells, 1997). Faust, Dimitrovsky, and Davidi (1997), using the tip-of-the-tongue paradigm, reported that 14 children with WFDs, ages 7;8 (years;months) to 8;9, provided equivalent semantic information but less phonological information about words they could not correctly retrieve than their TD peers. Second, phonological intervention seems beneficial. McGregor (1994) reported that two 5-year-olds reduced their phonological and semantic WFDs in response to phonological intervention alone. This intervention developed knowledge of words with regard to their onsets and their number of syllables. Similarly, German (2002) reported that two 8-year-old boys reduced their WFDs in response to phonological intervention that involved metalinguistic reinforcement, phonemic neighbor cues, and rehearsal strategies.

Three issues about intervention for children with WFDs are open to debate. First, as children respond positively to semantic intervention (Bragard & Maillart, 2005), phonological intervention (German, 2002; McGregor, 1994), or both (McGregor & Leonard, 1989; Wing, 1990; Wright, 1993), this leaves open the question of whether both types of intervention are needed or whether just one form of intervention can be used. To date, the relative efficiencies of these interventions are unknown because the findings of relevant studies are equivocal. Wing (1990) reported that phonological intervention was effective and semantic intervention was not. Wright, Gorrie, Haynes, and Shipman (1993) reported the converse, and Wittman (1996) reported that both interventions were equally effective. A second issue is that generalization is limited. Wright (1993) reported improvement on one outcome measure, the Test of Word Finding (German, 1989), but not on tasks other than confrontation naming tasks. Best (2005) reported that intervention for five children with WFDs, ages 6;10 to 10;7, involving a computerized aid that converted letters to sounds, did not generalize to untrained words. However, two of the five participants showed a significant reduction in WFDs in discourse. Third, intervention gains do not seem to be sustained over time. Wittman (1996), using a self-cuing intervention, reported a marked improvement in naming control and treatment pictures, but this improvement was not sustained 2 months after treatment. Wright reported that the generalization for confrontation naming tasks was also not sustained after intervention.

One item that may account for these differences in intervention outcomes and the lack of generalization is children's differing linguistic profiles. The hypotheses that WFDs reflect speech processing problems in the semantic and/or phonological domains (German, 1984; Lewis & Speake, 1998) imply that intervention should address both of these components. Examining the responses of children with different linguistic profiles to an intervention that combines phonology and semantics may help to illuminate (a) the nature of lexical deficits, (b) the different responses to intervention, and (c) the variations in maintenance of gains over the long term. The present study aims to do this by addressing the following four questions:

- Do children with WFDs benefit more from a semantic or a phonological intervention?
- If improvement occurs, is it related to the individual child's linguistic profile?
- If improvement occurs, are the effects maintained for 6 months?
- Does an intervention that incorporates phonological and semantic training help children to generalize to untrained items?

To answer these questions, a multiple single-case study was implemented, with each child acting as his or her own control. This type of design was chosen because of its capacity to isolate the impact of children's individual linguistic profiles on the intervention outcomes.

METHOD

Participants

Four Belgian, French-speaking children, ages 9;6 to 13;9, participated in this study. The inclusion criteria confirming SLI included (a) typical hearing; (b) typical nonverbal cognition indicated by a standard score of >85 on the Leiter International Performance Scale (Leiter, 1980); (c) no evidence of a pervasive developmental disorder or neurological impairment, as judged by a medical team; and (d) confirmed WFDs, based on the judgments of teachers and speech-language pathologists (SLPs). Intellectual quotient and results of language evaluation are presented in Table 1.

WFDs are failures to temporarily access words in the lexicon despite the speaker knowing the intended words (Dockrell et al., 2001; German, 1984). WFDs are not stable, as different words are usually affected when the stimulus task is repeated. The indicators of WFDs for this study were use of (a) semantic substitutions (e.g., *piano* instead of *guitar*), (b) phonological substitutions, (c) indeterminate responses (e.g., *thing, stuff*), (d) visual approximations or unrelated responses, and (e) circumlocutions (e.g., *it's for*

Table 1. Assessment results from the study participants' latest language evaluation.

	Emma	*Charlie*	*Bastien*	*Alex*
Age (years;months) at the latest assessment	11;8	9;0	13;3	12;8
Intellectual quotient				
Leiter nonverbal intelligence test	104	104	90	105
Phonology				
Difficult-words repetition task (L2MA)	1st P	1st P	16th P	1st P
Vocabulary				
Picture naming- substantive (ELO)	6th P	1st P	18th P	1st P
Picture pointing (PPVT)	15th P	9th P	18th P	9th P
Morphosyntax				
Utterance production (ELO)	1st P	1st P	< 3rd P	1st P
Picture pointing (ECOSSE)	1st P	3rd P	50th P	1st P
Verbal memory				
Digit repetition (CMS)	1st P	1st P	1st P	1st P

Note. L2MA = Langage Oral, Langage Écrit, Mémoire et Attention (Chevrie-Muller, Simon, & Fournier, 1997), this test assesses oral and written language, memory, and attention in children; P = percentile; ELO = Evaluation du Langage Oral (Khomsi, 2001), this test assesses receptive and expressive phonology, semantics, and grammar; PPVT = Echelle de vocabulaire en images Peabody (Dunn & Theriault-Whalen, 1993), this test is the French adaptation of the Peabody Picture Vocabulary Test (Dunn & Theriault-Whalen, 1993); ECOSSE = Epreuve de Compréhension Syntaxico-Sémantique (Lecocq, 1996), this test is the French adaption of the Test for the Reception of Grammar (Bishop, 1983); CMS = échelle de mémoire pour enfants (Cohen, 2001), this test assesses memory in children.

war, for launching missiles in response to a picture of a canon). Delays in naming were also an indicator of WFDs. The teacher's and SLP's judgments of the participants' WFDs were based on their unrelated responses to a questionnaire that was adapted from McGregor and Windsor's (1996) checklist.

All participants attended special education classes for children with SLI, and they continued to receive their usual twice-weekly literacy support during the intervention. The oldest participant, Bastien,[1] age 13;9, had weak phonological and lexical abilities as well as expressive morphosyntactic difficulties. His WFDs manifested as circumlocutions in his conversation. He began attending a special education class for children with SLI at the age of 9, with ongoing language support since then. Alex, the second oldest participant, age 13;3, had severe morphosyntactic receptive and expressive difficulties. He also had phonological difficulties but was intelligible in conversation. His WFDs were indeterminate responses and semantic substitutions such as saying *pear* for *tomato*. Alex's WFDs, indicated by the discrepancy between his expressive and receptive lexical skills, appeared to have a semantic basis because he failed a semantic judgment task[2] (experimental task in Bragard & Schelstraete, 2008). Alex started attending a special education class when he was 6 years old. His language intervention focused on WFDs, morphosyntax, and literacy centering on phonological awareness and sound confusions. Emma, the third oldest participant, age 12;3 had severe phonological and morphosyntactic receptive and expressive difficulties. Her conversation was intelligible but was marked by WFDs manifesting as indeterminate responses, circumlocutions, and naming delays. Like Alex, Emma's WFDs—indicated by the discrepancy between her expressive and receptive lexical skills—appeared to have a semantic base because she failed the aforementioned semantic judgment task. Emma started attending a special education class when she was 7 years old but had been receiving language intervention since she was 4 years old. Her language intervention focused on receptive vocabulary and phonology but not on WFDs. The youngest participant, Charlie, age 9;6, exhibited phonological and morphosyntactic receptive and expressive difficulties. His conversation was not always intelligible and contained WFDs that were mostly indeterminate responses. The discrepancy between his expressive and receptive lexical skills indicated the presence of WFDs. His WFDs appeared to have a phonological basis because he failed a phonological judgment task[3] (experimental task in Bragard & Schelstraete,

[1]Pseudonyms are used to protect the children's identity.

[2]A semantic judgment task was used to test the children's semantic representation accuracy. The participants simultaneously looked at a picture and listened to a word that was produced by a computer and indicated if they matched. Each word was presented three times: once with the correct picture, such as a dog; once with a semantic distracter, such as a wolf; and once with an unrelated picture, such as an apple. To pass, participants had to respond correctly to the three presentations.

[3]The phonological judgment task was used to determine the status of the phonological representation and required the participants to decide if a spoken presentation of a word matched the picture (i.e, [dʒəræv] instead of [dʒəræf] for the picture of a giraffe). This task was presented as a game in which the computer was learning how to speak and the child had to detect its errors.

2008). Charlie began attending a special education class when he was 6 years old. The goals of his language intervention were receptive and expressive phonology and morphosyntax. Notably, phonological cues helped all of the participants to retrieve words.

Measures

Picture-naming and -pointing test. The first outcome measure was a picture-naming and -pointing test (Bragard, Schelstraete, Collette, & Grégoire, 2010). The test contained 80 color photographs that were divided into four subsets of 20 words according to previously determined age-of-acquisition data (Chalard, Bonin, Meot, Boyer, & Fayol, 2003).[4] The words were selected to control for two factors affecting picture naming: phonological complexity and word length (Cycowicz, Friedman, Rothstein, & Snodgrass, 1997). Normative data were developed from ~140 children, 20 for each year of age within the age range of 7–13 years (Bragard et al., 2010). The picture-naming test required the children to name pictures that were displayed on a computer screen as rapidly as possible. After 8 s, participants were given the word's first phoneme; if this clue did not help, the first syllable, for bisyllabic words, was supplied. Three scores were determined for each word. The naming accuracy score was the tally of correctly named items, each attracting a score of 1. Only the first response participants gave was scored, with any subsequent names ignored. Prompted items were ignored for scoring, but this information was coded qualitatively. The second score was the mean latency time to name the picture. The third score was a classification of the naming error. The classifications were the aforementioned ones: semantic, phonological, indeterminate, visual, or circumlocutions.

The same 80 items were then used for the picture-pointing test. In this test, five pictures were displayed on a computer screen and a voice recorded on the computer said the name of one of them. Participants were required to choose the correct picture corresponding to that name. Four distracters were associated with each target item: a semantic one (e.g., *donkey* for *horse*), a phonological one that rhymed with the target word (e.g., *house* for *mouse*), a phonological one beginning with the same sound (e.g., *camera* for *chameleon*), and an unrelated item (e.g., *artichoke* for *pair of compasses*). Sometimes, the distracters were targets for other items. The participants indicated their choice by pressing the key corresponding to it.[5] Two scores were determined for each word. The first score was an accuracy score whereby correct items attracted a score of 1. The second score was a classification of the pointing error according to the type of distracter chosen: semantic, phonological-rhyme, phonological-first phoneme, or unrelated.

The picture-naming test was administered at the first and second pretest and at the first and second posttest (Figure 1); the picture-pointing test was only administrated at the first pretest. These measures also served as a secondary confirmation of WFDs at the first administration. To be included in the study, participants had to perform at least 2 *SD*s below the mean on picture naming (either for naming accuracy or for mean time latency) but had to perform better on the picture-pointing test than on the picture-naming test.[6]

Test of the specific targeted skills. The second outcome measure was the test of the specific targeted skills. The data regarding each participant's performance were collected before and after each intervention task. This test measured the participants' improvement on the intervention tasks, described below, whereas the first outcome measure, the picture-naming test, measured more global enhancement in word retrieval.

Intervention

To learn new words, the participants analyzed the phonological form of the word, derived its meaning, and connected the two in order to establish a representation of the word for storage in the lexicon. The intervention assumed that word learning involves specifying a concept phonologically and semantically (Barrett, 1995) and was then designed to achieve this. Phonological and semantic components were also included because weaknesses in them may cause WFDs (e.g., Constable et al., 1997; Dockrell et al., 2003; Faust et al., 1997; Lewis & Speake, 1998; McGregor & Appel, 2002; McGregor et al., 2002).

Implementation

The study involved five components, outlined in Figure 1. The first, fourth, and fifth components were pre- and posttesting sessions; the second and third components were the intervention phases.

Pretesting consisted of two sessions, 1 week apart, using the picture-naming test to determine the baseline and stability of the participants' picture-naming skills.[7] The participants'

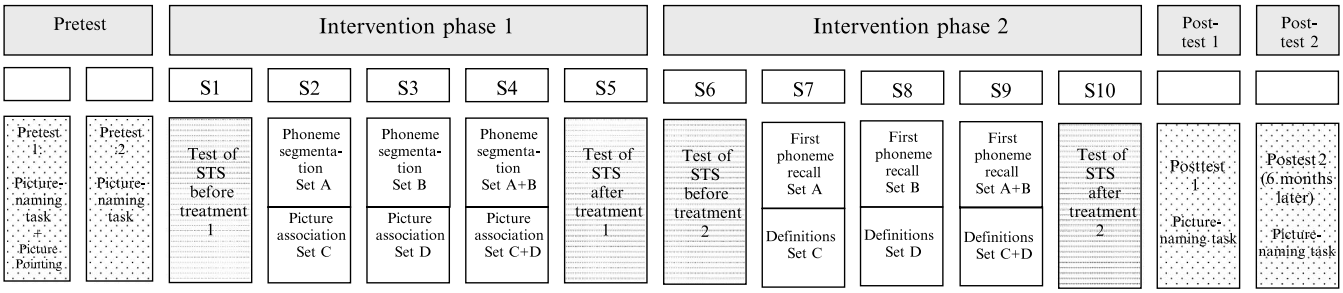
[4] The first set of words is usually acquired before the age of 3, the second set between ages 3;0 to 5;6, the third set between 5;7 and 8;6, and the last set of 20 words after age 8;6.

[5] Five color stickers were placed on the keyboard (letters Q, D, G, J, and L on an AZERTY keyboard), each one corresponding to one picture presented on the screen.

[6] Results were, respectively, 65% for the picture-naming test and 91.3% for the picture-pointing test for Emma; 60% and 87.5% for Charlie; 82.5% and 92.5% for Bastien; and 66% and 86% for Alex.

[7] Although the global scores were similar for each participant between the first and second picture-naming test, qualitative analysis revealed the presence of inconsistent naming: Some misnamed pictures were subsequently correctly named, and other correctly named pictures were subsequently misnamed. Because this study deals with WFDs, it seems obvious that some inconsistency would be present because a WFD occurs "when a target word is present in a child's receptive vocabulary but the child is unable to produce that word quickly and easily on demand" (Constable, 2001, p. 330).

Figure 1. Study design.



Note. S = session, STS = specific target skills, Set A = first half of the cards for phonological intervention, Set B = other half of the cards for phonological intervention, Set C = first half of the cards for semantic intervention, Set D = other half of the cards for semantic intervention. The first line of the figure illustrates the five components of the study, the second line refers to the intervention session number, and the third line specifies the content of each session.

scores were stable across the two measurement points because there were no significant differences between them, indicated by the McNemar test ($p = .48$ for Emma, $p = .08$ for Charlie, $p = .27$ for Bastien, and $p = .79$ for Alex).[8]

The second and third components of the study were the intervention phases; each of five weekly, individual sessions. The first and last session of each intervention phase was devoted to testing the specific targeted skills. The remaining sessions were consecutive, intervention ones, commencing with 15 min of phonological intervention followed by 15 min of semantic intervention. The same experimenter, the third author, implemented all intervention sessions, ensuring that only phonological intervention occurred in the phonology component and only semantic intervention occurred in the semantic component. All of the intervention tasks were presented as games, and feedback was provided (described in Appendix A).

The first phase of the phonological intervention focused on phoneme segmentation; the second phase focused on recall of the first phoneme of the word. These tasks were selected because they are associated with greater accuracy in picture naming after training for some children with WFDs (McGregor & Leonard, 1989). As phoneme segmentation is prerequisite to recalling the first phoneme of a word, it occurred in the first phase. Phoneme segmentation required participants to associate each phoneme of the word with a token, providing visual support. If participants could not name the picked picture, the experimenter supplied the missing word. In the recall of the first phoneme task, participants selected a picture from the stock and then attempted to remember the first phoneme to self-cue. If the participant could not recall the phoneme name, the grapheme was supplied. If the participant did not recall a word, the experimenter did not supply the missing word. Rather, to emphasize retrieval, participants were encouraged to find the word by self-cuing with the first "letter."

The first phase of the semantic intervention focused on semantic association; the second phase focused on definition. These tasks were selected because of evidence that (a) learning about similarities and differences between semantically related words facilitates word-finding skills (McGregor & Leonard, 1989) and (b) defining words increases a person's vocabulary knowledge (Nash & Snowling, 2006). In the semantic association task, participants selected two pictures and explained how they were associated. For each association using a new semantic attribute, the experimenter placed a picture of the attribute on the table. If the participant could not describe any associations, the experimenter provided some clues to direct the participant's attention to a particular feature. In the word definition task, participants selected a card and defined the illustrated word so the experimenter could guess its identity. Cards illustrating the different attributes the participant used were placed on the table. The experimenter completed the child's explanation, supplying the correct attributes and emphasizing the features that distinguished one item from another (e.g., the back differentiated a chair from a stool).

The fourth and fifth components of the study were posttesting, occurring 1 week and again 6 months after the intervention was completed. The picture-naming test was used in both sessions.

Intervention Pictures

A subset of the items from the 80-item picture-naming/pointing outcome measure previously described was used in the intervention, but colored pictures rather than photographs were used in this instance (Appendix B). All of the colored pictures were selected from the pictorial set developed by Rossion and Pourtois (2004) or from the Père Castor set (1995). There were three sets of 24 words: one for

[8]Data taken into account for the pretest refer to the data collected the first time.

phonological intervention, one for semantic intervention, and a control set. A unique feature of the design of this study was the inclusion of these three sets of words because they allowed for determining the impact of the phonological intervention and the semantic intervention. The first 12 cards from each set were used in the first session of each intervention phase; the second 12 cards from each set were used in the second session of each phase. Both sets of cards were used in the last session in each phase.

Scoring and Analyses

Each item from each of the phonological tasks was coded 1 if it was accurate and 0 if it was inaccurate. The semantic association items were scored according to the attributes used to associate items. For example, if *cherry* was associated with *tomato* because the pictures of them were both red, 1 point each was credited for *cherry* and *tomato* because this characteristic was relevant for both words. By contrast, if *boot* and *radish* were associated because the pictures of them were both red, 1 point was attributed for *radish* but nothing for *boot* because not all boots are red. Similarly, the items for the definition task were coded for the number of attributes given (e.g., color, shape, function, size). For example, a participant who defined the word *cherry* as *a little red fruit* obtained a score of 3 because of the relevance of three pieces of information provided (size, color, and semantic category). There was no maximum result for the semantic tasks.

The McNemar test (Siegle, 1956) was used to determine if the differences between pre- and posttesting were significant. This chi-square test for matched pairs allows examining for the direction of change between pre- and posttesting. It also indicates the extent to which the observed direction in the change is caused by chance. To ensure that any intervention gains were attributable to increased word retrieval and not to word learning, only correct items for the picture-pointing test were included in the statistical analyses, assuming that an incorrect response indicated that the meaning of the word was not known. The number of items taken into account was then different for each child.

RESULTS

Specific Targeted Skills

All participants made significant improvements in the specific targeted skills, as displayed in Table 2 and confirmed by the McNemar test. All participants made significant progress on the phoneme segmentation task, but none improved their retrieval of the first phoneme. Three of the four participants (Emma, Charlie, and Bastien) demonstrated significant improvements on semantic associations, and all participants improved their skill to define words.

Picture Naming

Number of words correctly named. WFDs significantly decreased for all participants on at least one of the three sets of words, confirmed by the McNemar test and displayed in Table 3. Two participants (Emma and Alex) displayed significant gains on the phonological intervention that was present at both posttests. Two participants (Charlie and Alex) displayed significant gains on the semantic intervention that was present at both posttests. No participants showed any changes for the control words.

Response times. None of the participants decreased their response time on the training items between pre- and posttest 1, indicated by the Wilcoxon test and displayed in Table 4. However, three participants (Charlie, Bastien, and Alex) decreased their response time between posttests 1 and 2 on the semantic and complete set.

Table 2. The results of each participant compared to his or her own performance before and after each intervention task (specific targeted skills [STS] session).

	Emma		*Charlie*		*Bastien*		*Alex*	
Task	*Pre STS*	*Post STS*	*Pre STS*	*Post STS*	*Pre STS*	*Post STS*	*Pre STS*	*Post STS*
Phonological								
Phoneme segmentation (phase 1)	7	17***	4	11**	0	20***	8	18***
Retrieval of the first phoneme (phase 2)	19	20	15	18	20	22	17	20
Semantic								
Semantic associations (phase 1)	14	22**	14	23*	7	43***	12	18
Definitions (phase 2)	39	67***	30	53***	46	82***	45	67***

Note. STS = specific targeted skills session. Maximal score for each phonological task was 24 (one trail per item). In contrast, because of the scoring used, the total opportunities were open ended for the semantic tasks.

*p = .05; **p = .025; ***p < .005.

Table 3. Children's performances on first picture-naming in the pretest, posttest 1 (1 week after the intervention was completed), and posttest 2 (6 months later).

	Emma			*Charlie*			*Bastien*			*Alex*		
Set	*Pre*	*Post 1*[a]	*Post 2*[b]	*Pre*	*Post 1*[a]	*Post 2*[b]	*Pre*	*Post 1*[a]	*Post 2*[b]	*Pre*	*Post 1*[a]	*Post 2*[b]
Complete	51/73	57	62	45/70	55*	57	61/74	67**	68	42/69	57***	57
Phonological	14/22	19**	20	15/23	19	20	17/22	21	22	15/22	21**	22
Semantic	15/22	16	18	8/18	14*	13	15/21	18	20	10/21	15*	16
Control	16/22	17	19	16/22	16	20	22/23	21	21	16/20	17	16

Note. Only well-pointed items were considered in scoring. The total number of items taken into account for each child is specified in the pretest column. Participants' scores on picture naming were stable across the first and second pretest. Thus, the second pretest is not reported to increase readability of the table.

[a]Significance tests indicate the difference between the pretest and posttest 1. [b]Significance tests indicate the difference between posttests 1 and 2.

*$p \leq .05$; **$p \leq .025$; ***$p \leq .01$.

Error analysis. The two most frequently occurring error types did not vary in ranking for all participants, but the less frequently ones did. However, each participant's individual profile of errors differed, indicated by changes in the percentage of each error type and/or changes in their rankings, displayed in Table 5. Semantic substitutions increased for three participants (Charlie, Bastien, and Alex) but decreased for one (Emma), whereas the frequency of phonological substitutions did not seem to change. Indeterminate responses decreased for two participants (Charlie and Alex), and visual approximations/unrelated errors percentage were variable for all participants. Finally, circumlocutions increased for three participants (Emma, Charlie, and Alex) and decreased for one (Bastien).

Emma' profile changed, with semantic substitutions and indeterminate responses decreasing and circumlocutions increasing. The changes in her profile contrasted with those of Charlie's and Alex's, as their semantic substitutions and circumlocutions increased and their indeterminate responses decreased, which was a similar pattern to their TD, same-age peers (Bragard et al., 2010). By contrast, Bastien's profile showed the least change, with the only change being that the number of his circumlocutions decreased. He showed the opposite error pattern to TD children because he used more indeterminate responses than semantic substitutions. Bastien was the participant who made the fewest errors in picture naming.

DISCUSSION

This study used a multiple single-case design to examine the effectiveness of an intervention that was designed to reduce WFDs in children with SLI. Four participants with confirmed SLI and WFDs, ages 9 to 13 years, took part in the study. Each of the six intervention sessions commenced with 15 min of phonological intervention followed by 15 min of semantic intervention. Following intervention, three participants experienced significantly fewer WFDs on trained words, with maintenance apparent 6 months later but no generalization to untrained words. The phonological intervention seemed more effective than the semantic

Table 4. The average time (ms) participants took to name the pictures at the pretest, posttest 1, and posttest 2.

	Emma			*Charlie*			*Bastien*			*Alex*		
Set	*Pre*	*Post 1*[a]	*Post 2*[b]	*Pre*	*Post 1*[a]	*Post 2*[b]	*Pre*	*Post 1*[a]	*Post 2*[b]	*Pre*	*Post 1*[a]	*Post 2*[b]
Complete	2155	2177	2192	2887	2652	2400*	2889	2473	2365*	2214	2358	1722***
Phonological	2310	2324	2090	2337	2512	1776	2645	2543	2396	2528	2318	1819
Semantic	2087	2168	2278	3112	2330	1817**	2581	2420	2025	1992	2838	1684**
Control	1548	1900*	2343	3207	2818	2521	2237	2333	2713	1907	2012	1620

[a]Significance tests indicate the difference between the pretest and posttest 1. [b]Significance tests indicate the difference between posttests 1 and 2.

*$p = .02$; **$p = .01$; ***$p = .001$.

Table 5. Error rate in the picture-naming task before and after the intervention.

Type of error	Emma		Charlie		Bastien		Alex	
	Pretest	*Posttest*	*Pretest*	*Posttest*	*Pretest*	*Posttest*	*Pretest*	*Posttest*
Semantic substitutions	57%	47%	56%	74%	29%	33%	41%	64%
Phonological substitutions	0%	1%	0%	1%	0%	0%	8%	7%
Indeterminate responses	30%	27%	41%	10%	57%	50%	33%	14%
Visual approximations/unrelated responses	10%	6%	3%	5%	0%	17%	0%	3%
Circumlocutions	3%	20%	0%	10%	14%	0%	15%	18%

intervention for two participants and the converse for one other participant.

Do Children With WFDs Benefit More From a Semantic or a Phonological Intervention Program?

This study indicated that intervention incorporating phonology and semantics was effective in reducing WFDs in three participants. Markers of phonological intervention effectiveness were that all participants significantly improved their phoneme segmentation after three sessions, and Alex and Emma had significantly more accurate picture-naming scores for the phonological intervention words. This intervention may have reinforced Emma's and Alex's phonological representations and strengthened their linkages between the lexical and phonological forms (Best, 2005). If so, this is consistent with the lexical restructuring model that Metsala and Walley (1998) proposed, whereby more richly specified words for phonological representations are more easily accessed. However, there are some indicators implying that the phonological intervention was not effective. First, none of the participants improved their recall of the first phoneme of words. However, this lack of change may reflect ceiling effects because the pretest scores were close to the maximum. Second, Charlie and Bastien did not improve naming pictures for the phonological intervention words.

The semantic intervention was effective because three participants made significant improvements on the word association task and all participants made significant gains in defining words. More precise word definitions and the inclusion of more semantic attributes were the indicators of improved word definitions, and these may reflect more fully specified semantic representations. Also, Charlie and Alex had significantly better picture-naming scores for the semantic intervention words, although Emma did not.

Is Improvement Related to the Individual Child's Linguistic Profile?

Each participant responded differently to the intervention, suggesting that their individual profiles influenced their intervention outcomes. This is true; however, these response patterns were counter-intuitive because participants with apparently semantically based WFDs (Emma and Alex) responded better to the phonological intervention than to the semantic intervention, whereas Charlie, with apparently phonologically based WFDs, responded better to the semantic intervention. Bastien appeared to make no changes, but this may be an artifact of his high pretest scores.

The participants' differential responses to the different tasks support the idea that WFDs occur at varying locations within the speech processing system (Lewis & Speake, 1998; Thomas et al., 2006). Our findings are also consistent with the findings for adults with acquired WFDs (for a review, see Nickels, 1997). Thus, these findings provide further evidence that intervention for children with WFDs needs to be tailored to individuals' linguistic profiles (McGregor & Leonard, 1995). This points to the need for more research to refine understanding about the causes of WFDs and illuminate why, for example, only some children with underspecified phonological representations also have WFDs (Maillart, 2003). Single-case studies lend themselves to investigating this interaction between weak phonological representations and semantic deficits because of their capacity to explore individual responses (Bragard & Schelstraete, 2007; Bragard, Schelstraete, & Lefèvre, submitted).

Maintenance: Do the Effects of the Intervention Remain After 6 Months?

This intervention achieved maintenance of gains with effects present 6 months after intervention ceased. This is a noteworthy finding because it is a longer period than that reported in other studies of 3, 4, or 10 weeks after intervention (Best, 2005; German, 2002; McGregor & Leonard, 1989). Although similar in period to the 8 months that Marks and Stokes (2010) reported, it is more robust because no diminution in gains occurred between the postintervention and follow-up testing, whereas Marks and Stokes found diminution. The stability in gains found in the present study may be attributable to the intervention used, but replication of these findings is needed to determine this.

Generalization: Does an Intervention That Incorporates Phonological and Semantic Training Help Children to Generalize to Untrained Items?

This intervention did not facilitate generalization because naming of the control pictures did not improve for any of the participants. This lack of generalization is consistent with and corroborates findings from other studies (Best, 2005; German, 2002; McGregor, 1994). An area of future research endeavor is to determine whether longer periods of intervention achieve generalization.

Limitations

The study findings need tempering to account for the study's limitations. First, the first-phoneme retrieval task showed a ceiling effect, which suggests that a different task should have been used, such as searching for the target word's phonological neighbors in order to facilitate retrieval (McGregor & Leonard, 1995). Related to this point, there was more capacity for changes on the semantic tasks than on the phonological tasks. Second, this design does not permit full separation of the effects of the phonological intervention from those of the semantic intervention (McGregor & Leonard, 1989). The participants may use a phonological strategy when naming the words in the semantic intervention and vice versa. Nevertheless, Zens (2009) demonstrated that children with SLI who received phonological awareness intervention before semantic intervention were more efficient in learning new words than children who received the interventions in the reverse order. These findings support the choice of providing phonological intervention before semantic intervention. Third, the need to balance the word sets for word length and age of acquisition may have compromised the participants in that the words may not be the ones they use in everyday talking tasks. The fourth limitation relates to the focus on picture naming and not on discourse, which is the functional setting where WFDs usually occur (McGregor & Leonard, 1995). Future studies could include discourse as an outcome measure, such as that used by Marks and Stokes (2010). The final weakness was that the assessors were not blind to the participant's status; this may have influenced the findings.

Clinical Implications

The study has several clinical implications. First, this study showed that intervention can significantly reduce WFDs after a short period of intervention—six 30-min sessions—with changes maintained for 6 months. Second, children's linguistic profiles may influence their responses to intervention such that semantic intervention improves phonologically based WFDs and vice versa. If this relationship stands, it implies that surface-level semantic errors do not necessarily imply a semantic deficit (Aubin, Belin, David, & de Partz, 2001; Hillis & Caramazza, 1995) and accounts for some of the results. For example, it accounts for Emma and Alex making more improvement with the phonological intervention than the semantic one when their WFDs were seemingly semantically based. Charlie exhibited the opposite pattern in that he presented with phonologically based WFDs and only exhibited improvement in the semantic intervention condition. These different responses to intervention indicate the importance of closely monitoring children's responses to intervention. They also indicate the need to work from children's strengths rather than on their weaknesses.

The lack of generalization reported in this and other studies underscores the need to provide intervention on the words that are relevant for the child (McGregor & Leonard, 1995) because if their improvements are confined to words that are treated, they need to be words that are part of the child's repertoire. This underscores the importance of involving the parents in the selection of intervention targets (Best, 2005). It also underscores the need to target a substantial number of words in intervention to help children in their everyday lives (Wright, 1993).

The positive findings of this study are encouraging, particularly the maintenance of gains. The findings also provide further evidence that the origins of WFDs vary and of the need for different interventions and careful monitoring of progress during intervention. Although these findings need future replication, they also indicate some future research directions.

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