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Phonological or morphological intervention? Evidence from a Greek-speaking child with persisting speech difficulties

Journal:	<i>Child Language Teaching and Therapy</i>
Manuscript ID	CLT-18-0011
Manuscript Type:	Original Manuscript
Keywords:	phonology, morphology, morphophonemes, intervention, speech disorder, Greek
Abstract:	<p>Intervention with children with speech and language difficulties has been proven beneficial compared with no treatment yet, knowing what type of intervention to provide remains a challenge. Studies of English-speaking children indicate that intervention targeting the production of morphological targets may have a positive effect on phonological aspects and vice versa. However, studies have not reported on generalization effects to untreated morphemes and little is yet known about morphological intervention in the context of a highly inflected language. The purpose of the current intervention case study was to investigate the effect of intervention in relation to phonological and morphological targets in Greek, a language characterized by complex inflectional morphology. A single subject research design was used with pre- and post-intervention assessment carried out. The participant was a four-year-old Greek-speaking boy with speech difficulties. The production of /s/, a phoneme used in multiple phonological and morphological contexts was targeted with alternating focus of intervention between phonological and morphological targets. Assessment took place at two levels: macro-assessment to monitor broad changes in speech; micro-assessment to measure therapy-specific changes in the production of treated targets and generalization to untreated targets and control items. There were four phases of intervention with a total of 24 hours of therapy. Significant improvement in performance accuracy was found between assessment scores immediately pre- and post-intervention. Intervention targeting the production of a phoneme in the word stem was not sufficient to accomplish the accurate production of morphemes requiring the same phoneme; intervention directly targeting morphemes was successful. Within-domain generalization was observed in both domains. Improved naming accuracy was observed post-intervention that was maintained at follow-up.</p>

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	The same speech processing intervention principles as are followed for the achievement of phonological objectives may be necessary for the accurate production of morphemes for children with speech difficulties.

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Introduction

Interactions between the levels of the language system may influence the linguistic performance of a person with communication difficulties (Crystal, 1987). Speech and language difficulties frequently co-occur (Broomfield and Dodd, 2004; Shriberg, Tomblin and McSweeney, 1999). The question of whether morphological errors of children with speech sound disorders reflect their phonological weaknesses has been raised (Haskill & Tyler, 2007; Rvachew, Gaines, Cloutier, & Blanchet, 2005; Seeff-Gabriel, Chiat, & Pring, 2012). An answer to this question would have important implications with regard to whether it is necessary to target the two domains separately or whether a more efficient, less time consuming approach can be adopted in the expectation that intervention for one domain (phonology) will generalize to the other (morphology).

The connection between errors in speech production and expressive morphology has been explored in English-speaking children attending speech therapy (Rvachew et al., 2005). Production accuracy of /s/, /z/ with morphological function (plural, possessive, third person singular) was lower compared with the production of these phonemes in uninflected words, suggesting that speech difficulties could not fully account for difficulties with morphology.

The association between morphological errors and underpinning phonological errors was investigated by Haskill and Tyler (2007) in subgroups of children with language impairment and varying degrees of speech difficulties. Morpheme production performance of participants facing difficulties solely with language was similar to typically developing controls; co-morbid difficulties had a cumulative effect on morphological production. A discrepancy in production of phonologically similar yet

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3 grammatically different forms suggests that the ability to produce specific phonemes may
4
5 not be sufficient for the accurate production of morphophonemes.
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8 A number of group studies (Tyler et al. 2002; 2003) of children with co-occurring
9
10 speech and language difficulties investigate the direct effects of intervention on a treated
11
12 domain, and indirect effects on areas other than the one targeted. Preschool age children
13
14 with impairments in both domains were randomly assigned either to intervention starting
15
16 with phonology followed by morphology, or the reverse (Tyler et al., 2002). Results
17
18 indicated that both treatment groups made statistically significant progress in the treated
19
20 domain as compared to controls who did not receive any intervention. Overall
21
22 morphosyntactic performance was slightly better when morphosyntax was targeted prior
23
24 to phonology, suggesting that children's speech does not have to be fully intelligible for
25
26 morphological intervention to commence.
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30
31 Tyler et al. (2003) further compared the outcomes of different strategies with
32
33 intervention targeting: (a) phonology followed by morphology, (b) morphology followed
34
35 by phonology, (c) alternating phonological – morphological targets weekly, (d)
36
37 simultaneously targeting phonology and morphology. No single strategy was superior in
38
39 improving phonology post-intervention. The alternating strategy was associated with
40
41 greatest gains in morphosyntax. The authors draw attention to high variability in
42
43 intervention outcome for individual participants in the same group, suggesting that one
44
45 type of intervention may not have been equally beneficial for all. Differences in starting
46
47 level and type of errors among participants led to variation in intervention outcome.
48
49 Therefore, individual analysis would be revealing about treatment efficacy for particular
50
51 profiles of difficulty. Such an analysis is more feasible within the context of a single case
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3 study, to elucidate individual differences and allow for an in depth evaluation of
4
5 treatment efficacy (Pascoe, Stackhouse and Wells, 2005).
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7
8 A first single case study in the area of morphological and phonological change
9
10 following intervention was conducted by Seeff-Gabriel, Chiat and Pring (2012). Their
11
12 participant, an English-speaking child aged 5 years old and referred to as B, had difficulty
13
14 with the production of regular past tense, although he was able to produce /t/, /d/ in
15
16 word final position, suggesting that his difficulty could be morphosyntactic. He had
17
18 difficulty with the production of plural nouns and was unable to produce /s/, /z/ at all in
19
20 final position, suggesting a difficulty with alveolar fricatives at the phonological or
21
22 articulatory level. Intervention initially targeted the production of regular past tense; upon
23
24 intervention most errors were observed in verbs requiring the past tense ending /ɪd/,
25
26 indicating that past tense marking was influenced by phonological factors. Intervention
27
28 then targeted the production of final /s/ as a phonological precondition for the accurate
29
30 production of regular plural nouns. Upon intervention B was able to produce word final
31
32 /s/ accurately, but word initial and medial targets did not improve. Although B
33
34 consistently used a word final consonant to mark plural, phonologically accurate
35
36 production was limited. A third phase of intervention directly targeted /z/ in word final
37
38 position. Upon intervention B was able to produce /z/ accurately in monomorphemic
39
40 targets; he realized final /z/ as a plosive when it was required for plural marking,
41
42 indicative of an interaction between speech and morphosyntax. This study demonstrates
43
44 how single case studies can reveal in detail the reciprocal relationships between
45
46 phonology and morphology.
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3 Pascoe et al. (2005) put emphasis on theoretical basis on intervention studies,
4
5 presenting the case of Katy a 6;5 years child with persisting speech difficulties. In order
6
7 to inform intervention at single word and connected speech levels, the speech processing
8
9 model and profile as described by Stackhouse and Wells (1997) were used. The speech
10
11 processing model distinguishes between distinct levels of input processing (skills
12
13 involved in decoding speech), output processing (skills involved in encoding and
14
15 production of speech) and lexical representations i.e. stored knowledge about a word's
16
17 form (phonological representation), meaning (semantic representation) and specific
18
19 articulatory gestures required for production (motor program). The speech processing
20
21 profile, a series of questions tapping into different components of speech processing can
22
23 reveal individual strengths and weaknesses. A theory based approach allows clinicians to
24
25 deliver principled intervention and to be explicit in interpretation of the intervention
26
27 outcome. The psycholinguistic approach has been successful in profiling Greek children
28
29 with speech sound disorders (Geronikou and Rees, 2016).
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35 In summary, researchers have attempted to investigate to what extent difficulties
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37 with expressive morphology may be attributed to speech production errors (Rvachew et
38
39 al., 2005; Haskill and Tyler, 2007) and the impact that therapy on one domain may have
40
41 on another (Seeff-Gabriel et al., 2012; Tyler et al., 2002; 2003). Data from children with
42
43 speech difficulties point to an interaction between phonology and other linguistic levels,
44
45 although the nature of this interaction is not yet clear. Provision of intervention for
46
47 children with primary speech and/or language difficulties has proven beneficial compared
48
49 with no treatment (Broomfield and Dodd, 2011). Provision of the most effective
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51 intervention for each case remains a challenge. Intervention on morphological targets
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3 when the level of phonological skills development is insufficient for the proper
4 realization of morphophonemes has not been studied in highly inflected languages.
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8 The purpose of the current intervention case study was to investigate the effect of
9 intervention for phonological and morphological targets in Greek. Notable features of the
10 Greek language are its complex inflectional system (Holton, Mackridge, & Philippaki-
11 Warburton, 1997) and the use of polysyllabic stems (Aidinis and Nunes, 2001). Greek
12 children have to process polysyllabic stems for commonly used words as [kɛrɛ'mɛl-ɐ]
13 (candy) in combination with the appropriate morpheme for case and number. The study
14 in the context of complex morphology could elucidate aspects of the organization of
15 lexical representation, including grammatical representations, which may not be feasible
16 to study in morphologically simpler languages. Longitudinal investigation in typically
17 developing Greek-speaking children provides evidence that comparable speech
18 processing skills underpin the development of phonology and morphology (Geronikou,
19 2016).
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35 A single case study design was chosen to allow detailed analysis of performance
36 during phases of intervention and to promote insight into the organization of stored
37 linguistic knowledge and its articulation in a particular child.
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42 On account of the findings of morphophonological intervention in English-
43 speaking children (Tyler et al., 2002; 2003) and speech processing development in
44 Greek-speaking children (Geronikou, 2016) the following broad questions are addressed
45 with regard to intervention for a child with phonological and morphological difficulties :
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3 a. If intervention in the phonological domain results in change, will the change be
4 restricted to the phonological domain or will generalization occur to the untreated
5 morphological domain?
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10 b. If intervention in the morphological domain results in change, will the change
11 be restricted to the morphological domain or will generalization occur to the untreated
12 phonological domain?
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17 c. Will there be positive effects on speech production accuracy as a result of
18 specific intervention targeting either phonological or morphological domains?
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24 25 Methods and Procedures

26 27 Participant

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30 Harry was 4;2 years old at the time of first assessment, and was attending nursery
31 in a public school setting in Patras, Greece. There was no history of medical problems.
32
33 He had achieved developmental milestones as expected. He had normal hearing and
34 vision; he spoke Greek as his first language. He had just been referred to speech and
35 language therapy.
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41
42 To be considered for intervention delivery within the context of the present
43 intervention study, the age of 4;0 years old was set as a criterion, since in typical
44 development the production of the phoneme /s/ has been acquired at this age and the
45 phonological process of final consonant deletion in closed syllables is eliminated when
46 the syllable is at the end of the word (Papathanasiou et al., 2012). A second selection
47 criterion for speech difficulties was set, namely indicated by ≤ -1.5 S.D. from age
48 matched controls performance on Percentage Consonants Correct (PCC) in a naming
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3 task. Harry scored 61.4% PCC compared to 89.84% (12.07 S.D.) of typically developing
4
5 controls aged 4;0-4;6 years (Geronikou, 2016). The criterion of -1.5 S.D. below the
6
7 mean performance of typically developing children has been frequently used (Law et al.,
8
9 2000) in identifying children needing intervention. Harry could not produce the target
10
11 phoneme accurately in CV structure and consonant clusters; /s/ and /z/ were constantly
12
13 substituted by laterals [ʎ] and [ʒ] respectively, irrespective of phonotactic context and
14
15 morphological status. He also substituted /r/ by [l].
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20 Design

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23 In order to investigate the broad research questions stated above, Harry's
24
25 production of /s/ was targeted in different intervention phases with the focus of
26
27 intervention alternating between phonological and morphological components.
28
29

30 The following specific research questions are addressed:

- 31
32 1. Once /s/ is realized accurately by the child in a particular phonotactic structure is there
33
34 generalization to the production of the same phoneme in other structures?
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38 2. Once /s/ is realized accurately by the child in a particular morpheme is there
39
40 generalization to the production of other morphemes that also require the production of
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42 /s/?
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45 3. What is the effect of phonologically oriented intervention for /s/ on production of
46
47 grammatical morphemes that require the production of this phoneme?
48
- 49
50 4. What is the effect of morphologically oriented intervention on the production of /s/ as
51
52 part of the phonological system?
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55 5. Is there a change in the child's speech production accuracy as a result of this
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57 intervention?
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3 A single subject research design was used. Baseline assessment was carried out
4
5 twice: two months pre-intervention and immediately pre-intervention. Four phases of
6
7 intervention, focusing on phonological characteristics of targets (at odd-numbered
8
9 intervention phases) and morphological characteristics of targets (at the even-numbered
10
11 intervention phases) were conducted. Post-intervention assessment was carried out twice:
12
13 immediately post-intervention and two months post-intervention.
14
15

16 17 **Macro assessment:**

18 A detailed assessment battery (Geronikou, 2016) was used pre- and post-
19
20 intervention to monitor broad changes in speech input and output processing and
21
22 language comprehension and production abilities. Given the second selection criterion,
23
24 PCC performance accuracy will be presented here. This measurement is based on data
25
26 from the Greek adaptation of Renfrew Word Finding test (Vogindroukas, Protopapas and
27
28 Sideridis, 2009). Black and white line drawings were presented for the child to produce a
29
30 spoken response. No data is presented from the other aspects of the assessment battery.
31
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34 35 **Micro assessment:**

36 In order to measure therapy-specific changes a number of stimuli (Appendix 1)
37
38 were used to collect repeated measures of probe assessment pre- and post-intervention
39
40 and upon completion of each intervention phase. In the latter case, they were carried out
41
42 at the beginning of the next session.
43

44
45 The research design is illustrated in Figure 1.

46
47 **Insert Figure 1**

48 49 50 **Intervention Phases**

51
52 In Greek, the target phoneme /s/ is used in multiple phonological contexts in the word
53
54 stem in C₍₀₋₃₎-V-C₍₀₋₁₎ structures, in syllable initial (SI), word initial (WI) and word within
55
56
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(WW) position. Consonant clusters such as /sk, st, sp/ are never used in syllable final (SF) position (Mennen and Okalidou, 2006). It is also used in a variety of morphological contexts to indicate the grammatical status of words such as gender, case and tense (Holton, Mackridge and Philippaki-Warburton, 1997). Relevant examples will be given in the following section. The corresponding voiced phoneme /z/ is used in SIWI and SIWW position in the word stem and as a morpheme for continuous tenses but it is not related to noun morphology.

Phase 1

The production of /s/ for phonological purposes was targeted in the word stem, in CV structure at SIWI position as ['sinɛfo] (cloud) and SIWW position as [ni'si] (island). There were 20 SIWI and 20 SIWW treated items. Six intervention sessions were designed.

Phase 2

The production of /s/ for morphological purposes was targeted in the word suffix, in SFWF position for the manifestation of a) genitive case for feminine nouns in singular (GFS) as [mɛ'mɛs] (mum's) and b) accusative case for masculine nouns in plural (AMP) as ['ɛdrɛs] (men). Stress can be on any of the last three syllables (Arvaniti, 2007); the inflected form (compared to the nominative case) does not involve change of stress position but requires the presence of /s/ as a suffix. There were 20 GFS and 20 AMP treated items. Six intervention sessions were designed.

Phase 3

The production of /s/ in the consonant clusters /sk/ and /ks/ for phonological purposes was targeted in the word stem; in WI as ['ksilo] (wood) and WW position as ['tokso] (bow). There were 15 /sk/ WI and 10 /sk/ WW treated items, 10 /ks/ WI and 10 /ks/ WW treated items. Seven intervention sessions were designed.

Phase 4:

The production of /ks/ for morphological purposes was targeted as a suffix of simple past tense, in the final syllable as ['fonɛksɛ] (shouted). There were 12 treated items for /ks/ used as a past tense morpheme. Five intervention sessions were designed.

Procedure and Materials:

Probe assessment

A picture-naming task was used in repeated probes to assess:

Therapy-targeted treated items

For each of the intervention goals, three of the treated items were selected, for example ['skɛlə] (ladder) a treated item for the target /sk/ in SIWI position. Treated stimuli (Appendix 1, first column) were used to evaluate intervention outcome on items directly targeted.

Therapy-targeted untreated items

For each of the intervention goals, three items with phonological or morphological properties identical to the treated items were selected; for example, ['skavi] (digs) for the target /sk/ in SIWI position. These items that carefully remained untreated during intervention (Appendix 1, second column) were used to evaluate cross-item generalization.

Not targeted in therapy – control items

For each of the intervention goals, three items with phonological or morphological properties similar, yet somewhat different from the targets were selected; for example words with cluster /st/, not targeted in intervention were matched to the targeted cluster /sk/. Control items (Appendix 1, third column) were used to observe any possible within domain generalization.

Not targeted in therapy, more distinctive items:

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2
3 For each intervention goal, items sufficiently different from those included in
4 intervention, yet within domains of phonology or morphology were selected for example,
5 corresponding to /s/ clusters /r/ clusters. Distinctive stimuli (Appendix 1, fourth column)
6 were used to evaluate broad-spectrum development of skills. If the child succeeded on
7 treated and untreated items, but not on these more distinctive items it would suggest that
8 change observed could be attributed to intervention. Comparison of performance during
9 periods of no intervention delivery would suggest if any noticeable change could be
10 attributed to maturation.
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21 Regardless of the phase where each target was introduced, the same stimuli were
22 used as micro-evaluation in all probe assessments.
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25

26 Intervention delivery

27 A four-phase intervention plan with predefined activities for the production of /s/
28 in phonological and morphological contexts was designed. Harry received speech therapy
29 sessions for 45 minutes twice a week for three months (24 sessions) by the first author.
30
31
32
33

34 Principles of traditional articulation therapy (Van Riper and Emerick, 1984) were
35 adopted, targets being graded from simpler to more complex structures. With regard to
36 phonological elements, accurate production of /s/ was targeted in the word stem in CV
37 phonotactic structures in Phase 1 and in CCV structures in Phase 3. With regard to
38 morphological elements, accurate production of /s/ was targeted in CVC phonotactic
39 structures in the word ending in Phase 2 and CCV structures in Phase 4. Accurate
40 production was progressively targeted at syllabic, word and sentence level.
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50 The other set of guiding principles that informed intervention planning was
51 provided by psycholinguistic theory. Care was taken to include activities addressing
52 potential difficulties at various levels of input and output processing that might hinder the
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3 realization of /s/ in spontaneous speech. From a psycholinguistic perspective the
4
5 difference between imitation and spontaneous production of phonological targets
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7 (Appendix 2, activity 1) and morphemes in context (Appendix 2, activity 3) is interpreted
8
9 in terms of different requirements for access to stored representations.
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11

12 In accordance with the psycholinguistic approach, the focus of intervention was
13
14 also on the input processing of phonological and morphological components. Tasks
15
16 tapping auditory discrimination (Appendix 2, activity 2) were used. Materials commonly
17
18 used with children of this age were used. Activities included colorful pictures, for him to
19
20 name and pairs of pictures, phonologically or morphologically similar, for him to identify
21
22 which he had heard.
23
24

25
26 Harry followed the therapeutic activities at his own pace, for as many times as
27
28 needed to reach 80% criterion of success in a particular activity.
29
30

31 32 33 34 Results

35 36 37 Performance during intervention phases

38
39 Harry's performance on repeated probe assessments across intervention phases
40
41 can be seen in Table 1. Inspection of the first column in shaded boxes indicates whether
42
43 change is observed once a specific target has been introduced in intervention (research
44
45 questions 1 & 2). The last column in shaded boxes indicates whether intervention
46
47 outcome is preserved at follow-up. Inspection of performance down the rows, outside the
48
49 shaded boxes, indicates whether there is an effect of targeting something in one phase on
50
51 other items that have not yet been targeted in intervention (research questions 3 & 4).
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54
55 **Insert Table 1**
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3 Probe assessment revealed that performance was stable in baseline assessment for
4 a period of two months before the initiation of intervention. Production of the target
5 phoneme was inaccurate in CV structure and in consonant clusters.
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10 Once a target was introduced in intervention performance improved, for example
11 accurate productions of /s/ in CV structure were observed upon completion of Phase 1.
12
13 There was some generalization to targets that had not yet been introduced in intervention
14 for example accurate productions of /sk/ and inaccurate production of /st/ upon
15 completion of Phase 1, when clusters had not been targeted. Within domain
16 generalization to untreated items was observed both for phonological (upon completion
17 of Phase 1) and morphological targets (upon completion of Phase 2). Across domain
18 generalization was not observed.
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28
29 Two months post completion of intervention delivery Harry retained the ability to
30 produce accurately /s/ in SIWI and SIWW position, in CV and CCV structures both for
31 treated and untreated items. He did not produce accurately /s/ in SFWF position, when
32 required for the manifestation of morphemes. He produced /ks/ as a morpheme of simple
33 past.
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41 Comparison of pre- and post-intervention performance

42
43 To investigate the effectiveness of intervention pre- and post-intervention
44 performance accuracy on micro-assessment (Figure 2) and macro-assessment (Figure 3)
45 were compared.
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49

50 **Insert Figure 2**

51
52 A Cochran's Q test indicated a statistically significant difference between scores
53 for treated ($\chi^2(3) = 54.33, p < .001$), untreated ($\chi^2(3) = 56.86, p < .001$) and control items
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3 $(\chi^2(3) = 19.85, p < .001)$ at the four points of assessment. Pairwise comparison of
4
5 performance accuracy was performed using two-tailed McNemar tests with Bonferroni
6
7 correction for multiple comparisons. A value of $p > .008$ indicates a difference that would
8
9 not maintain significance under Bonferroni correction.
10

11
12 Performance accuracy on probe assessment post-intervention was significantly
13
14 better than performance pre-intervention for treated ($p < .001$) and untreated items (p
15
16 $< .001$). Two months post-intervention Harry scored significantly lower than immediately
17
18 post-intervention for untreated items ($p = .001$) indicating that the effect of intervention
19
20 was not maintained fully. Some effect of intervention was maintained since his score two
21
22 months post-intervention remained significantly higher than his score pre-intervention for
23
24 treated ($p < .001$) and untreated items ($p < .001$).
25
26

27
28 A significant difference was found between performance accuracy for control items
29
30 immediately pre-intervention and immediately post-intervention ($p = .008$); no significant
31
32 difference was found between performance pre-intervention and two months post-
33
34 intervention ($p = .500$), so there was no lasting effect of intervention on control items.
35
36

37 38 **Insert Figure 3**

39
40 A Cochran's Q test indicated a statistically significant difference between PCC
41
42 scores at the four points of assessment ($\chi^2(3) = 65.02, p < .001$). Pairwise comparison
43
44 was performed using two-tailed McNemar tests. A statistically significant difference was
45
46 found between performance accuracy immediately pre-intervention and immediately-post
47
48 intervention ($p < .001$). Increase in PCC accuracy was maintained two months post-
49
50 intervention.
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52

53 54 55 **Discussion**

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3 The main issues driving this intervention case study concern whether any effects
4 of treatment are limited to the domain that has been targeted. A further interest is whether
5 such specifically targeted interventions lead to a broader change in speech production.
6
7 These issues were operationalised in term of five specific research questions, which will
8 now be considered in the light of Harry's performance.
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16 Generalization of /s/ from one phonotactic structure to other 17 structures within the phonological domain 18

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20 When therapy follows a phonological direction some generalization of /s/ to other
21 lexical items and other phonotactic structures was observed, for example accurate
22 production of clusters once CV structure was targeted. Across item generalization has
23 been commonly reported as an intervention outcome in the literature of speech sound
24 disorders (Pascoe et al., 2005; Seeff-Gabriel et al., 2012). Generalization of the target
25 phoneme was partial indicating that Harry did not store /s/ as a single member of the
26 sound system that can be used in different phonotactic positions.
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37 Generalization of a morphological target to other morphological 38 targets 39

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41 When therapy follows a morphological direction, Harry was able to generalize to
42 the appropriate production of untreated morphological targets and not targeted controls
43 that require /s/ in WF position. This finding allows the hypothesis that morphological
44 characteristics are an integral part of lexical representations. Within the speech
45 processing model proposed by Stackhouse and Wells (1997), updating stored motor
46 programs of words with the intention that morphemes can be accurately generated could
47 be expected to stimulate motor programming skills, leading to some revision or updating
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3 of the child's current stored representations. Phonological representations and motor
4 programs may need to be specified as to the different morphemes that can be attached in
5 semantic representations (word stem). Existing studies with English-speaking children
6 have not yet reported on a morphological intervention outcome with other untreated
7 morphemes.
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16 The effect of phonologically oriented intervention on production of 17 grammatical morphemes 18

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20 The next question to be considered is whether therapy aiming at the production of
21 the phoneme /s/ in phonological contexts will facilitate the production of morphemes that
22 require the accurate production of that phoneme. In the case of Harry no such
23 generalization occurred. This was particularly evident upon completion of Phase 3. Harry
24 was able to produce target /ks/ accurately as [ks] in SIWW position, when included in the
25 word stem but he maintained substitution by [kl] in morpheme production of simple past
26 tense, which entail the same cluster in the same word position. As a result of intervention
27 targeting the phonological details of morphological suffixes Vance (1997) reports the
28 development of some awareness and use of these endings, that was not systematic in
29 spontaneous speech. In the present study the development of phonological competence
30 was not sufficient to trigger the production of accurate morphemes. Intervention directly
31 targeting the accurate production of morphemes was required.
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48 The effect of morphologically oriented intervention on the 49 production of phonemes 50 51

52 Regarding gains in the phonological domain, when intervention targets the
53 production of morphemes generalization to phonological targets was not observed. Group
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3 studies for English-speaking children (Tyler et al., 2002) indicate that addressing the
4 morphosyntactic level leads to improvements at the phonological level.
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8 9 **Change in speech production accuracy as a result of intervention**

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11 There were beneficial effects of the intervention program to speech production
12 abilities; Harry's performance post-intervention reveals more than 10% increase in PCC
13 accuracy rate in spontaneous naming, similar to findings of intervention studies with
14 English-speaking children, such as those of McNeill, Gillon and Dodd (2009) and Tyler
15 et al. (2003). It seems that Harry developed lower level execution skills that enabled him
16 to produce phoneme /s/ in a wide range of positions and phonotactic structures and he
17 also created more accurate motor programs.
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28 29 **Comments on intervention outcome**

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31 Two months post-intervention, maintenance of correct production of phonological
32 targets was better preserved compared with morphological ones. The production of /s/ in
33 the WF position was not preserved at all. An explanation could be that phonemes found
34 at the word end are more vulnerable, due to the co-articulation with phonemes which
35 follow. Another explanation could be that since the phoneme /s/ in WF position is not
36 required in each case of a noun, the frequency of its use is lower than in instances where
37 the phoneme is in the word stem and thus obligatory in every context. This is supported
38 by the fact that accurate production of /ks/ in WW position is higher when included in the
39 word stem than when it is required as a past tense suffix.
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52 53 **Conclusions**

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3 The current study is the first study reporting controlled intervention with a Greek-
4 speaking child who did not have the necessary speech processing skills for the accurate
5 production of a phoneme that is used in morphological context.
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10 Targeting the accurate production of morphemes enabled him to specify the
11 phoneme at the level of lexical representations. Development was extended to speech
12 production skills.
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17 Cross-domain generalization from phonology to morphology was limited. This
18 has some clinical implications, indicating that in a comprehensive intervention the
19 production of morphemes may need to be targeted, even in the absence of accompanying
20 language difficulties, in the case that speech errors are involved in morpheme production.
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26 27 28 **Acknowledgements**

29 The authors thank Harry and his family for participating in the study.
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For Peer Review

	2 months pre- Intervention	Pre-Intervention	Phase 1	Phase 2	Phase 3	Phase 4	2 months post- Intervention
Phase 1: Phonological /s/ in word stem							
Targets treated /s/	0/6	0/6	4/6	0/6	3/6	5/6	4/6
Targets untreated /s/	0/6	0/6	1/6	0/6	5/6	4/6	3/6
Not targeted controls /z/	0/6	0/6	0/6	0/6	0/6	0/6	0/6
Phase 2: Morphological /s/ in word suffix Genitive Feminine Singular (GFS) , Accusative Masculine Plural (AMP)							
Targets treated /s/ GFS, AMP	0/6	0/6	0/6	6/6	4/6	5/6	0/6
Targets untreated /s/ GFS, AMP	0/6	0/6	0/6	6/6	6/6	6/6	0/6
Not targeted controls /s/Accusative Feminine Plural	0/6	0/6	0/6	6/6	6/6	6/6	0/6
Distinctive controls /n/ Genitive Plural	6/6	6/6	6/6	6/6	6/6	6/6	6/6
Phase 3: Phonological /s/clusters in word stem							
Targets treated /sk/	0/6	0/6	3/6	1/6	5/6	5/6	6/6
Targets untreated /sk/	0/6	0/6	1/6	1/6	1/6	6/6	6/6
Not targeted controls /st/	0/6	0/6	0/6	0/6	3/6	2/6	2/6
Targets treated /ks/	0/6	0/6	0/6	0/6	3/6	4/6	4/6
Targets untreated /ks/	0/6	0/6	0/6	0/6	1/6	5/6	3/6
Not targeted controls /ps/	0/6	0/6	0/6	0/6	0/6	0/6	0/6
Distinctive controls /tr/	0/6	1/6	3/6	3/6	3/6	4/6	4/6
Phase 4: Morphological /ks/ simple past suffix							
Targets treated /ks/ past	0/3	0/3	0/3	0/3	0/3	3/3	1/3
Targets untreated /ks/ past	0/3	0/3	0/3	0/3	0/3	2/3	1/3
Not targeted controls /ps/ past	0/3	0/3	0/3	0/3	0/3	0/3	0/3
Distinctive controls passive voice	1/3	1/3	3/3	2/3	2/3	3/3	3/3
Performance on items that have been targeted in intervention is enclosed in shaded boxes							

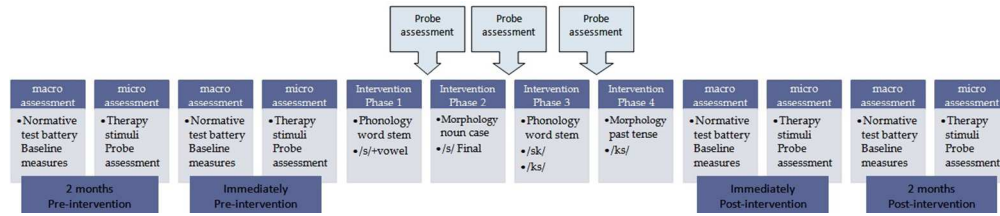


Figure 1 Research design

338x71mm (96 x 96 DPI)

For Peer Review

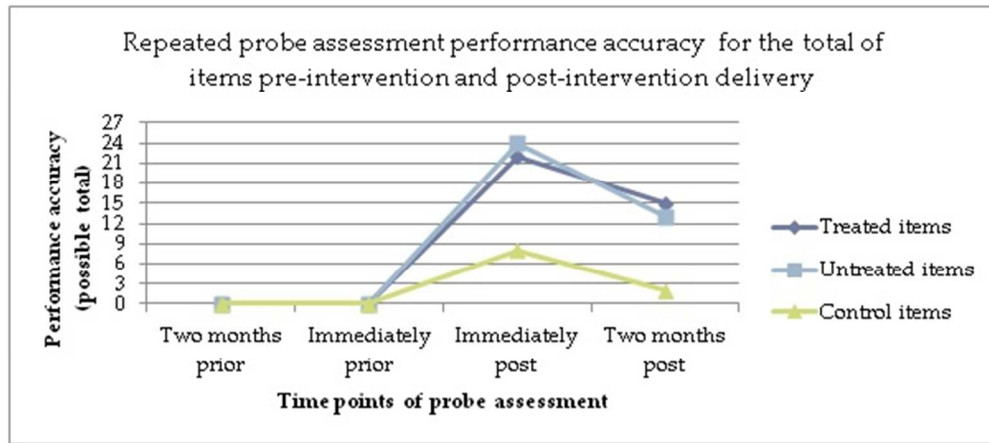


Figure 2 Comparison of Harry’s performance in probe assessment for the total of treated, untreated and control items at baseline pre-intervention and post-intervention delivery

160x71mm (96 x 96 DPI)

Peer Review

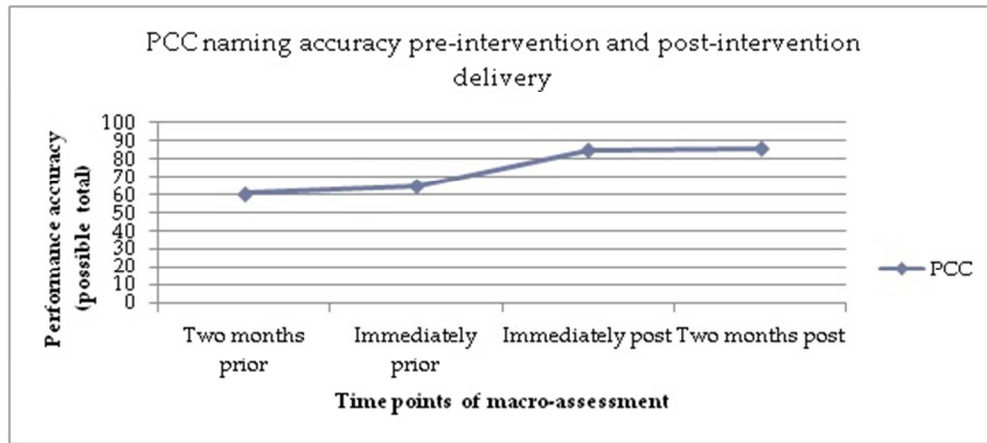


Figure 3 Comparison of Harry's performance in naming task scored for the Percentage of Consonants Correct (PCC) at baseline pre-intervention and post-intervention delivery

160x71mm (96 x 96 DPI)

Appendix 1 Probe assessment items

	treated		untreated	not targeted controls			distinctive controls	
Phase 1 Phonological								
SIWI	[ˈsupɛ]	soup	[sokoˈlɛtɛ]	chocolate	[zɛˈcɛtɛ]	jacket		
	[ˈsinɛfo]	cloud	[sɛˈkulɛ]	bag	[ˈzɛxɛri]	sugar		
	[sɛliˈgɛri]	snail	[suˈvlɛci]	skewer	[ˈzɔɛ]	animals		
SIWW	[çɛˈresi]	cherry	[ˈmɛlise]	bee	[ˈvezɔ]	vaze		
	[puˈkɛmisɔ]	shirt	[musiˈci]	music	[kuˈzine]	kitchen		
	[ˈmɛjise]	witch	[tileˈoresi]	TV	[mɛˈzɛrɛ]	meter		
Phase 2 Morphological								
/s/SFWF FGS	[çɛˈlonɛs]	turtle's	[oˈbrɛlɛs]	umbrella	[ˈmɛlisɛs]	bees	[moˈru]	baby's
	[kukuˈvɛjɛs]	owl's	[ˈkotes]	hen	[ˈbluzɛs]	blouzes	[kɛˈpɛlo]	hat's
	[ɛjɛˈlɛðɛs]	cow's	[ˈɣɛtɛs]	cat	[oˈbrɛlɛs]	umberela s	[ˈmilu]	apple's
/s/SFWF MAP	[ɛˈlɛfɛdɛs]	elephants	[kɛrxɛˈries]	sharks	[pɛpɛˈɣɛlos]	parrot	[pɛpɛˈɣɛlon]	parrots'
	[ˈkokɔrɛs]	roosters	[ˈmɛjires]	cooks	[ˈlikɔs]	woolf	[ˈlikɔn]	woolves's
	[ˈɛdrɛs]	men	[ɛˈtus]	eagles	[lɛˈɣɔs]	rabbit	[lɛˈɣɔn]	rabbits's
Phase 3 Phonological								
/sk/ WI	[ˈskɛlɛ]	ladder	[ˈskɛvi]	digs	[stɛˈfili]	grape	[ˈtrɛno]	train
	[ˈskɛci]	chess	[skɛˈdzoçiros]	hedgehog	[ˈstome]	mouth	[ˈtrɛçi]	run
	[skuˈlici]	worm	[ˈscilos]	dog	[stɛˈfɛni]	crown	[ˈtroi]	eat
/sk/ WW	[ˈproskɔpo]	scout	[voˈskɔs]	shepherd	[ˈfustɛ]	skirt	[jɛˈtros]	doctor
	[kɛˈskɔl]	scarf	[biˈskoto]	biscuit	[ɛstiˈnomɔs]	policema n	[ˈvɛtrɛxɔs]	frog
	[fuˈskono]	blow	[ˈmɛskɛ]	mask	[muˈstɛci]	mustache	[ˈcitrino]	yellow
/ks/ WI	[kɛˈplɔno]	lie	[kɛciˈnɛo]	start	[ˈpsɛri]	fish		
	[ksiˈfies]	swordfish	[ˈksifɔs]	sword	[psɛˈliði]	scissors		
	[ˈksilo]	wood	[ksiˈrɛfi]	razor	[ˈpsino]	grill		
/ks/ WW	[ɛksoˈçi]	countryside	[ˈɛmɛksɛ]	carriage	[ɛˈpopɛ]	tonight		
	[ˈmikɛ]	snot	[ˈɛniksi]	spring	[ˈjipɔ]	plaster		
	[ɛˈmɛksi]	car	[mɛksiˈlɛri]	pillow	[tɛˈpsi]	pan		
Phase 4 Morphological								
/ks/ / simple past morpheme	[ˈðjɛlɛksɛ]	chose	[ˈpɛtɛksɛ]	threw	[ˈɛnɛpsɛ]	lit	[ciˈmɛtɛ]	is sleeping
	[ˈfonɛksɛ]	shouted	[ˈɛnikɛ]	opened	[ˈɛkopɛ]	cut	[ˈplɛnɛtɛ]	is washed
	[ˈɛpɛksɛ]	played	[ˈtilikɛ]	wrapped	[ˈɛvɛpsɛ]	painted	[xtɛˈnizɛtɛ]	is combed

Appendix 2 Sample activities used during the intervention sessions

Sample activity 1

Target: update of stored motor programmes in the word stem: the production of /s/ in WISI position.

Pictures of words are presented, for the child to name each one. If /s/ WISI is accurately produced, activity continues. If /s/ production is inaccurate corrective feedback is given on positioning of the articulators. If the second attempt is inaccurate then a model is given for the child to imitate.

Sample activity 2

Target: update of stored motor programmes in the word suffix: elicited production of feminine nouns in genitive case in singular number.

Pictures of feminine nouns (i.e. /ɛjɛ'ləðə/ cow) are presented and a carrier phrase (this tail is...whose?) is used to elicit production in genitive (/ɛjɛ'ləðəs/ cow's). If both case and /s/ suffix are accurately produced activity continues. If genitive case is not produced, the need for the noun to be in genitive is explained. If /s/ production is inaccurate, corrective feedback is given on positioning of the articulators.

Sample activity 3

Target: Auditory discrimination of nominative-genitive case in the word suffix

Pairs of stimuli identical or differing by case suffix (/ɛjɛ'ləðə/-/ɛjɛ'ləðəs/cow-cow's) are auditory presented. The child is asked to decide if the stimuli heard were same or different. If the decision is correct, activity continues. If the child fails to discriminate the therapist repeats the pair with prolonged duration of /s/. If the child fails twice, visual and tactile information is used as corrective feedback.