

# Teaching compound words to a spelling-disabled child via Smart Notebook Technology: A case study approach

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**Abstract.** The case-study aims to examine the effectiveness of training of morphological structure on the spelling of compounds by a spelling-disabled primary school student. The experimental design of the intervention was based on the word-pair paradigm and included a pre-test, a training program and a post-test (n= 50 pairs). The Training Program aimed to offer systematic, targeted and step-by-step instruction of morphological decomposition of words to the student and delivered via the Smart Notebook educational software. The intervention had a substantial impact in enhancing the spelling of compounds by the individual. Especially, instructional gains were statistically significant, and generalized substantially to untrained but analogous words and pseudowords in terms of structure and common stems. These findings are particularly important for the development of alternative approaches to the educational interventions of individuals with spelling difficulties and developmental dyslexia, and are consistent with the experimental literature.

**Keywords:** spelling disability, morphology, intervention, case-study

## Introduction

Recent experimental evidence suggests that awareness of the internal structure of words is linked to spelling development in a variety of alphabetic orthographies (Arnbak & Elbro, 2000; Bryant, Nunes, & Bindman, 1999; Sénéchal, Basque, & Leclaire, 2006). It is also proposed that the processing of morphological units aids the retrieval of orthographic patterns during spelling. Students with dyslexia or literacy difficulties are usually disabled in their spelling performance in comparison with their age mates, and, in many cases, with younger children of the same reading ability (Bryant, Nunes, & Bindman, 1999). The difficulties appear to be more substantial in the spelling of morphologically complex words, which are the inflected, derived or compound words, in relation to their simpler base forms (Deacon, Parrila, & Kirby, 2006).

Compounding is one of the richest sources of word formation in everyday language, but more importantly in literary and scientific texts (Ralli, 2005). Longitudinal studies have demonstrated that children of typical development acquire simple compounds very early and in a fairly consistent developmental sequence (Nicoladis, 2006). The developmental patterns that emerge from these sources indicate that children initially start out by treating compounds as single entities, then as a means of putting together two nouns with a semantic relation between them (Berman, 2009). Cross-linguistic findings suggest that children can have some understanding about the function of simple noun-noun compounds as young as 2 years of age, at least for English-speaking children (Clark, 1993). Greek children's awareness of nominal compounds in terms of frequency and familiarity has been also observed from 2 years and 10 months (Stephany, 1997). Following stages in later development and once literacy is well established, children are expected to make use of

compounding as an option for the enrichment of their language (Berman, 2009). In that sense, other types of compounds may become more challenging, due in part to their lower frequency and greater complexity (Fowler & Liberman, 1995).

Given the effects of morphological knowledge to spelling, current suggestions involve that systematic and sequential instruction of morphology is needed during the elementary years of schooling (Sénéchal & Kearnan, 2007). Reed (2008) suggests that morphology may play a very important role by providing students of all ability levels enhanced access to word spelling and meaning, especially for those who did not adequately respond to explicit and systematic phonics instruction. However, intervention studies in this field are still rare, while the major body of evidence is more extensive in English than in other alphabetical systems.

A pioneering training study of morphological awareness in dyslexic students was conducted by Elbro and Arnbak (1996; Arnbak & Elbro, 2000), where the experimental group of 33 students aged 10 and 12 years with severe reading and spelling difficulties received training in morphological awareness of compounding, derivational and inflectional morphology for about 45 min per week over a period of three months. The experimental group made gains relative to the controls in morphological awareness and the spelling of compounds and derivations.

In another study, Nunes and Bryant (2006) aimed to teach 200 children of about 9.5 years old about the distinction between common derivational suffixes based on spelling principles. The intervention study entailed a pre-test, a post-test and two intermediary training sessions via PC of 20 minutes each that were completed in approximately 10 days. Findings showed that the three taught groups spelled significantly better the derived words than the control group after intervention, suggesting that the explicit teaching of suffixation seemed to be the most effective way of producing an improvement in children's spelling. Relevant were the data resulting from the spelling of pseudowords as an effective means of principle learning, verifying that children were able to generalize their spelling knowledge as well as to these items.

Recently, Wolter and Dilworth (2013) investigated morphological training effects on twenty and graded children with spelling deficits allocated in two intervention groups: (i) a group trained on phonological and orthographic awareness activities, and (ii) a group trained on phonological, orthographic and morphological awareness activities. Results of this study showed that the morphological awareness intervention group performed better on standardized spelling, spelling of morphological patterns and a measure of reading comprehension, while there were no differences between the groups on spelling of orthographic patterns. The studies above, conducted mainly in English, gave the empirical evidence that morphological interventions could be of a great benefit not only to children of typical development but also to those with difficulties in spelling acquisition. However, training studies of this kind are even scarce in other languages, such as Greek.

The present study aims to investigate the effectiveness of morphographic training on the spelling of compound words by one primary school student who face particular difficulties in spelling acquisition. The study employs a case-study approach as the most appropriate way to examine spelling disability (Seymour, 1998). Individual variation has been studied so far mainly within the scope of the identification of deficits and very few reports focused in the study of variation in terms of responsiveness to treatment (Carlisle, 1995).

The training was implemented via Smart Notebook educational software (Smart Technologies, 2007). This powerful and easy-to-use application enabled student to interact positively with verbal stimuli projected on the computer screen. Computer-assisted learning

is of great importance for the students with learning disabilities. Main benefits that are integrated in the production of computer-based training programs are the multisensory learning, the promotion of visual coding strategies and the active participation of the student through recreational and learning targets of their content. The advantages of these multi-modal programs are that they can capture student's interest, creating strong motivations for learning and knowledge acquisition (Kast et al., 2011). Additionally, they can offer a systematic and sequential way of teaching learning content, which is the most appropriate way to train students with learning disabilities (Detheridge, 1996). In the last decades, there have been developed a variety of programs for students with learning disabilities aiming to train spelling and/or other literacy abilities, focusing mainly on the phonological processing deficits (Brooks, 2007; Kast et al., 2011; Ecalle et al., 2009) of these students, and to a lesser extent to other linguistic abilities.

### ***Main hypotheses of the study***

In particular, the main hypotheses for the intervention study were the following: (i) The individual would increase substantially his total spelling performance after intervention as an effect of the morphographic training, despite his particular low performance before intervention (Nunes & Bryant, 2006; Tsesmeli, 2002; Tsesmeli & Seymour, 2009); (ii) Generalization effects will be further examined hypothesizing that untrained items and pseudowords of similar structure would evoke transfer-of-learning effects (Wysocki & Jenkins, 1987; Tsesmeli & Seymour, 2009) after intervention. Moreover it is expected, pseudowords would evoke stronger generalization results since they include common stems with the trained items, an additional element which is not present on untaught ones (Bowers & Kirby, 2010); (iii) Nouns and adjectives are assumed to be spelled higher than verbs (Tsapkini et al., 2002; Tsesmeli & Seymour, 2006). Thus, it is anticipated that this effect will be present before the intervention, however the training would increase performance on compounds by each word class, but particularly on verb items (Tsesmeli & Seymour, 2006); Finally, (iv) findings show that phonetic errors are particularly common on dyslexic children's spellings (Carlisle, 1987). It is hypothesized that morphographic training would have a positive effect in decreasing this type of errors (Arnbak & Elbro, 2000; Tsesmeli, 2002, 2010).

## **Method**

This study is based on a single-case research design as the most sensitive way to study individual differences in contrast to group designs that they focus to averages of groups. This kind of design, where the participant serves as his/her own control, is considered as the most appropriate design to evaluate intervention effects in applied research. In this study, the baseline assessment is used which means that before the treatment is implemented, the participant is evaluated via psychometric assessments in order a basis of his abilities to be established. If the treatment reverses this baseline trend, as evaluated by a post-intervention evaluation, then this is powerful evidence suggesting a treatment effect (Kazdin, 1982). This process is presented in more detail in the sections below.

### ***The Participant***

The participant who took part in the study was following the 5<sup>th</sup> grade of a primary school in the prefecture of Dodecanese in Greece. He was suggested to participate in the study by his teacher due to his difficulties in spelling acquisition. His native language was Greek and he had no any sight, hearing, mental or serious health problem.

### ***The Preliminary assessment***

Before commencement of the intervention study, the participant was given a series of psychometric assessments to evaluate more thoroughly his reading performance, knowledge of morphology and acquisition of vocabulary, and confirm the presence of literacy difficulties. These assessments are presented in detail as follows:

#### **(a) Reading performance**

Reading performance was evaluated in terms of reading of words and non-words and passage comprehension. These were all subtests of the standardised Test of Reading Performance (TORP; Padeliadu & Sideridis, 2000) which is a comprehensive evaluation of reading ability in Greek.

Reading of words was evaluated by the similar subtest of the TORP. Especially, the student had to read real words (n=40 items) taken from school reading books and ordered by ascending phonological difficulty and word frequency. Similarly, in the Reading of pseudowords subtest, the student had to decode pseudowords (n=19 items) of ascending phonological difficulty.

Passage Comprehension estimated students' ability to comprehend text. The student had to read silently six different texts of ascending difficulty and to answer multiple-choice questions referred to the meaning of the text.

#### **(b) Morphology knowledge in written speech**

Knowledge of morphology in written speech was evaluated (N=37 items) by the relevant sub-test of TORP (Padeliadu & Sideridis, 2000) which entailed three exercises assessing acquisition of morphological rules in Greek. In the first exercise (Morphology component), students had to utilize the text to make the right choice of tense and person providing the relevant suffixes, while in the second and third exercise (Syntax component) the student had to choose the correct grammatical type of a given word.

#### **(c) Understanding of written vocabulary**

Understanding of vocabulary in written speech was evaluated by the standardised test of Tafa (1995) where the student had to read and then to complete 42 open-ended sentences, after choosing the suitable word from a multiple choice scheme that fits syntactically and semantically in the sentence.

### ***Results of psychometric assessments***

Table 1 presents the results of psychometric evaluation for the participant. Data showed that the participant had intact abilities on reading non-words, indicating an appropriate acquisition of the phonological code of the language, and syntax. However, he presented significant difficulties in reading words and vocabulary (centile: < 5<sup>th</sup> and 16<sup>th</sup> respectively), which seemed to affect seriously his reading passage comprehension (centile: < 20<sup>th</sup>). Acquisition of written morphology and spelling words presented to be mildly affected (centiles for both: 50<sup>th</sup>), however the pre-test spelling of our intervention study including complex word forms, which are appropriate for his age level and needed for his school learning, was particularly low (15%, see Table 2). Since the ultimate aim for this student was to enhance his reading comprehension in order to improve his academic achievement in school at a later point (Bowers & Kirby, 2010), it was decided to enhance firstly his spelling of complex forms as a moderator for improving his reading comprehension (Gilbert, Goodwin, Donald, Compton, & Kearns, 2013). For this reason, the implementation of the intervention study focused on the spelling of these morphologically complex forms and is presented in full detail in the next section of the paper.

**Table 1. Psychometric tests for the spelling-disabled student**

	N	% Centiles	
Reading words	33/40	82.50	< 5 <sup>th</sup>
Reading non-words	19/19	100	100 <sup>th</sup>
Spelling words	26/60	43.33	50 <sup>th</sup>
Morphology	29/38	76.31	50 <sup>th</sup>
Syntax	6/6	100	100 <sup>th</sup>
Reading Comprehension	11/18	61.11	< 20 <sup>th</sup>
Vocabulary	26/42	61.901	16 <sup>th</sup>

### ***The Intervention study***

The experimental design of the study was based on Tsismeli and Seymour's (2009) earlier study which aimed to train derivations on English-speaking students. The experimental stimuli of this study are described in detail in the next section.

### ***Experimental Stimuli***

The study was based on the word-pair paradigm which was first introduced by Derwing (1976) as a way of evaluating the word relatedness in terms of meaning. In this study, each pair consisted of two compounds sharing a common stem and was used as an index of the application of morphological strategies in spelling. The items included one list of word pairs, the List of Compounds (n= 40 pairs) being relevant with his developmental stage of literacy.

The compound items in the list divided into four different word categories: (i) 10 nouns (e.g., βιβλιοθήκη-βιβλιοπωλείο /vivliothiki-vivliopoleio/ [library-bookshop]; (ii) 10 adjectives (e.g., καλοπληρωμένος-καλότυχος/kalopliromenos-kalotichos/ [well paid-fortunate]; (iii) 10 verbs (e.g., ανθοστολίζω-ανθοφορώ /anthostolizo-anthoforo/ [decorate with flowers-blossom], and (iv) 10 prefixed verbs (e.g., παραμένω-παραβλέπω /parameno-paravlepo/ [remain-overlook]).

For the purposes of the training study, each list was divided into three subsets of items: (1) Trained items (n=24 pairs) were the word-pairs used in the Training Program (e.g., βιβλιοθήκη-βιβλιοπωλείο /vivliothiki-vivliopoleio/ [library-bookshop]; (2) Untrained items (n=8 pairs) were words which did not receive any direct instruction. They were relevant to trained items in terms of word structure but without common stems (e.g., θαλασσοταραχή-θαλασσοπνιγμός/ thalassotarachi-thalassopnigmos/ [rough sea- sea drowning], and (3) Pseudowords (n=8 pairs) did not receive any instruction but they were analogous to trained items in terms of word structure and common either the first or the second stem of compound (e.g., βιβλιοκασετίνα-βιβλιομολύβι /vivliokasetina-vivliomolivi/ [book case-book pencil]. The full list of items is given in the Appendix.

### ***General procedure of the study***

Each study included a Pre-test, a Training Program and a Post-test. The procedure of the study lasted 6 sessions and implemented by the second author in the spring semester of the school year in two months' time.

### ***Assessments before and after the Teaching program***

All the items for the study were randomised to form the pre- and post-test. The test was given individually to the student by the second author and lasted two sessions of about 40 minutes. Both compound words were instructed to dictation as a pair (e.g., βιβλιοθήκη-βιβλιοπωλείο /vivliothiki-vivliopoleio/ [library-bookshop]). The student had to write down the spellings on two A4 sheets marked with two separate columns, placing the one compound in the left column and the other compound in the right column.

### ***Training Program***

The Training Program was also implemented by the second author in four sessions of about 40 minutes for the student. These separate Teaching units were involving instruction on six word-pairs which were assigned to a particular grammatical category (nouns, adjectives, verbs, prefixed verbs).

The program aimed to teach the student in a step by step way the internal structure of the words and how this is related to their spelling. Each session had a sequential and structural nature and was based on the active participation of the individual facilitated considerably by the use of the Smart Notebook educational software. More specifically, instruction was targeted towards four main principles: (i) word structure - every compound word is composed of two stems and a suffix; (ii) stem consistency - similar stems of the compound words are spelled identically. The sessions were divided into three main phases, referred to as the Workshop, the Discussion, and Practice on word-pair spelling. The Workshop based on student's own implicit understanding of word structure. The child was presented with a pair of words in black on the PC screen and asked to analyze the word into its constituent morphemes, to spell the one stem, then the other stem and finally to create the new word by combining the one stem and the other one appropriately. The Discussion phase aimed to make the relationships between familial words more salient. To this end, all word-pairs presented in colour, and in particular, the common stems of the compounds were printed in red, while the rest of the compounds were illustrated in blue. All the coloured word-pairs were presented on the screen together to facilitate a discussion on the principles of compound formation. Spelling practice followed Discussion and aimed to make explicit how the knowledge of word structure links with the spelling of the word-pairs based on accuracy. This means that the child should write on paper each word-pair at least 3 times correctly before proceeding to the next pair.

### ***Apparatus and procedure***

All individual sessions of the Training Program were delivered via Smart Notebook educational software (Smart Technologies, 2007). This powerful and easy-to-use application enabled student to interact positively with verbal stimuli projected on the computer screen. Especially, he could easily identify and move the appropriate morphological constituents of the words, while the use of colour and font size enhanced the salience and clarity of the words. Moreover, teaching sessions were audio-recorded and analyzed in precision after intervention, giving in this way the appropriate feedback to the experimenter to reflect on her training and student' learning behaviour. To this end, there were used the following materials: a) a personal laptop, b) electronic pages with verbal stimuli (in black and colour) and c) a microphone for audio-recording teaching sessions.

All teaching sessions delivered to the child in a quiet room in the school. In the beginning of the Training Program, a teaching session was given to the student in order to familiarise himself with the educational software.

**Table 2. Spelling accuracy rate (%) for Taught, Untaught words & Pseudowords**

	Pre-test	Post-test	Gains
<b>Taught compounds</b>	14.58	79.17	64.59
<b>Untaught compounds</b>	12.50	50.00	37.50
<b>Pseudo-compounds</b>	18.75	75.00	56.25
<b>Total</b>	15.00	72.50	57.50

### **Scoring procedure**

The spellings produced in the pre- and post-tests were classified as conventionally correct or as errors. Every accurately spelled word was assigned 1 point and every misspelled word 0 points.

### **Results**

The effectiveness of the intervention was evaluated in terms of the improvement in performance on the Post-test relative to the Pre-test, referred to as the 'gain' score.

#### **Main Training and Generalization effects**

Table 2 shows accuracy rates for pre- and post-tests of the intervention study for the participant along with his gain scores. According to the first hypothesis, the individual would enhance substantially his total spelling performance as an effect of the training. The significance of the gains was tested by Wilcoxon Signed-Ranks Test which is a non-parametric test used for a two condition related design when the same participant perform under both conditions and in the situation where the hypothesis of the normal distribution of the data could not be assumed (Greene & D'Oliveira, 1993). Results verified significant effects for training for the participant ( $W=-6.782$ ,  $p<.001$ ), indicating that the individual presented a significant change following the intervention.

The generalisation of learning was tested by comparing pre- and post-test results for the Trained, Untaught words and Pseudowords. According to the second hypothesis, if the training generalizes across the wider set of morphologically complex words bearing a similar word structure, then we would expect the gains to extend from Trained words to the Untaught ones, and to a greater extent to homologous Pseudowords, given they do share common stems with the Trained items. Table 2 also illustrates participant's spelling performance before and after intervention on these three sets of words. These data was tested by Wilcoxon Signed-Ranks Test. Results on Trained items revealed that intervention effects were mostly significant for the individual ( $W=-5.568$ ,  $p<.001$ ), while data from the Untaught items showed that generalization effects were significant for the participant ( $W=-2.449$ ,  $p<.05$ ). Similarly, the data from the Pseudowords revealed that generalization effects were stronger for the participant, ( $W=-3.000$ ,  $p<.05$ ), due to the common stems with the Trained items.

#### **Training effects on compounds in terms of word class**

Aiming to explain further the findings of the intervention study, it was explored possible training outcomes in relation to the word class of the words. Table 3 illustrates spelling scores on these items, namely on the Nouns, Adjectives, Verbs and Prefixed Verbs showing that the individual's performance on each of these categories was low, but particularly weak for the verbs and the prefixed ones.

**Table 3. Spelling accuracy rate (%) for compounds in terms of word class**

	Pre-test	Post-test	Gains
<b>Nouns</b>	35.00	85.00	50.00
<b>Adjectives</b>	25.00	55.00	30.00
<b>Verbs</b>	00.00	85.00	85.00
<b>Prefixed verbs</b>	00.00	65.00	65.00

**Table 4. Rate (%) for Phonological errors**

	Pre-test	Post-test	Gains
Phonological errors	25.00	12.50	12.50

According to the third hypothesis, the training would increase performance on these items. The significance of training on these data was tested by Wilcoxon Signed-Ranks Test. Results showed that performance on Nouns and Adjectives was significantly higher after intervention for the individual (respectively:  $W=-3.162$ ,  $p<.01$ ,  $W=-2.449$ ,  $p<.05$ ), and this effect was stronger for Verbs ( $W=-4.123$ ,  $p<.001$ ), including the Prefixed ones ( $W=-3.606$ ,  $p<.001$ ).

### ***Training effects on Phonetic errors***

It has been shown previously that an important aspect of this type of interventions was to decrease significantly performance on the phonetic errors, which is a common error type in children with learning disabilities (Arnbak & Elbro, 2000; Tsesmeli, 2002, 2010). Table 4 presents the percentage of the phonetic errors made by the student before and after the intervention, while the Wilcoxon Signed-Ranks Test showed that these errors were decreased significantly after the intervention ( $W=-3.162$ ,  $p<.01$ ).

## **Discussion**

This case study aimed to determine how far explicit training of morphological structure could improve the spelling of compounds by a primary Greek school student who faced particular difficulties in spelling. The training based on Tsesmeli and Seymour's (2009) earlier study in English-speaking students, and confirmed strongly the main hypotheses and aims of the study.

In particular, before the commencement of the study, the individual presented serious spelling difficulties on the total amount of compounds mostly at a level of 15%. However, the intervention attempted to over-double spelling accuracy to the individual up to a ceiling level (72.50%), while the trained items were received an important raise of 64% gains.

An important issue in the evaluation of the intervention studies concerns the degree to which training effects generalize across items (Seymour, 1998). In this study, there was a good evidence of generalization, indicating that the individual of our study was able to transfer instructed knowledge from trained compounds to untrained ones that are related only in terms of morphological structure (gains on untrained items: 37%). More importantly, generalization effects were much stronger on pseudo-compounds (56%), due to sharing a common stem with the trained compounds. This finding is in consistency with Nunes and



Bryant (2006), and Tsesmeli (2002; also in Tsesmeli & Seymour, 2009) where children also transferred principle learning among derivational items of similar word structure.

But how performance is varied among different types of items in terms of word class? The data showed that, before the beginning of the study, the participant had better performance on nouns (35%) and adjectives (25%) than on verbs (0%), including the prefixed ones (0%), a finding which corroborates with other relevant studies (Tsapkini et al., 2002; Tsesmeli & Seymour, 2006; Tsesmeli & Koutselaki, 2013) on spelling compounds by typical and learning disabled spellers, which is possibly attributed to the fact that nouns and adjectives are considerably more frequent than verbs in written literature. However, after intervention, the individual attempted to increase significantly his performance on nouns (gains: 50%) and adjectives (gains: 30%) but more considerably on prefixed and non-prefixed verbs (gains: 85% and 65% respectively).

Moreover, before the onset of the training, the individual of our study, despite his 5th grade of primary schooling, exhibited a fairly large percentage of phonetic errors (25%), which were misspellings where the phonological structure of the words has been mildly distorted (e.g., *καλοπληρωμένος*/kalopliromenos/[well-paid] spelled as *καλοπριλομένος*/kaloprilomenos/). This is a common feature of children with a spelling disability and/or developmental dyslexia and reflects an inability to attain the phonetic strategies required for the acquisition of the orthographic stage in every language (Seymour & Duncan, 2001). However, the participant decreased substantially his phonetic errors (12.50%) through the morphographic training, a finding that was firstly reported by Arnbak and Elbro (2000) and is consistent also with studies by Nunes and Bryant (2006) and Tsesmeli and Seymour (2009) on English-speaking students, and Tsesmeli (2010) on Greek-speaking students from a wide grade range (Grades 2 to 6) of primary schooling. In relation to this pattern of the morphographic training effect, it should be noticed that there might be a reason which might be related with the type of the linguistic unit as a target of the training, such as the morpheme. According to Mattingly (1987) boundaries between larger linguistic units, such as morphemes, are more salient, in relation to smaller linguistic units, such as syllables or phonemes, hence, the mappings between orthography and phonology of these structures are more explicit and easier to be perceived by the novice reader. Thus, a morphographic training that targets to the morphemes, it seems to facilitate a better reorganisation of the phonemes included within these morpheme boundaries than those within words.

Another issue that should be addressed at this point, is that the morphographic training of our study employs different types of items for instruction, that is the compound words, if compared with other similar studies, where derivations and inflections were used as systematic targets for the training of English-speaking (Nunes & Bryant, 2006; Tsesmeli, 2002; Tsesmeli & Seymour, 2009) and of Greek-speaking students (Tsesmeli, 2010). Mastery of compounding is usually accomplished relatively later in the school life, coinciding with a phase where children are learning to become proficient spellers, and is related significantly with enhanced vocabulary and reading comprehension (Gilbert, Goodwin, Donald, Compton, & Kearns, 2013). This process is thought to be longer and more open-ended for children of typical development, but is disrupted for children who are experiencing spelling difficulties (Mann & Singson, 2003).

Hence, the findings of the present study have several important implications for educational practice, most notably that morphological awareness is of importance and that training of the morphological structure of the words would be beneficial to students who experience serious spelling disability. Instructional practices for these students, and also for children in the whole spectrum, might usefully include training in morphological strategies. Students may need to apply in a specific and concrete way the most abstract ideas of internal word

structure. This process could be further assisted via colour-coding techniques and appropriate educational software to enhance active participation of the learner to the task, as in this study. Hines (2009) underlined the importance of the use of colour-coding techniques to enhance the effectiveness of the intervention for students who are presenting or being at serious risk for reading/spelling disabilities, since they are making the sublexical units more salient to children's eyes, and thus helping them to transfer these decoded units to other uninstructed items. In this way, generalization would be more effective to other homologous words, which is an issue of great importance for these children. She argues that possibly the limited transfer and their failure to use analogies about different linguistic units is, due to the fact that these units are not so salient enough for them to draw generalizations. One way to improve the effectiveness of the relevant instruction is to make these patterns more explicit with a colour-coding system that highlights those pattern similarities for categorizing, discriminating and identifying the word families (Hines, 2009, p. 23). To this end, these colour-coding and other relevant techniques were implemented in the most appropriate way via the Smart Notebook educational software (Smart Technologies, 2007), which helped particularly the student to interact positively with verbal stimuli and understand better their internal structure.

Some of the limitations of this study would be the lack of an appropriate control group (Backman, Mamen, & Ferguson, 1984), due to practical circumstances, most notably of the chronological age group, to facilitate individual's comparison with his age scores. Nonetheless, the data confirmed recent experimental findings on morphological training in Greek (Tsesmeli, 2010) and other language systems (Arnbak & Elbro, 2000; Nunes & Bryant, 2006; Tsesmeli, 2002; Tsesmeli & Seymour, 2009). The specificity of the morphological training effects could be further verified by untrained dyslexic cases matched in terms of chronological age and cognitive measures as in other intervention studies (Bryant, Nunes & Bindman, 2000; Elbro & Arnbak, 2000). One important question for future research would be the investigation of the acquisition of these mostly complex forms, such as compounds and their response to treatment in a number of different individuals that might differ in their cognitive ability and degree of literacy disability, in the absence and need of relevant studies (Carlisle, 1995; Snowling, 2000).

However, this study is one of the first attempts of morphographic training on compounding in Greek. The findings showed that training was particularly effective in enhancing the spelling of complex Greek words, and most notably to produce significant transfer-of-learning effects to analogous uninstructed words and pseudowords. These findings are consistent with the experimental literature (Arnbak & Elbro, 2000; Nunes & Bryant, 2006; Reed, 2008) and particularly important for the development of alternative approaches to the educational interventions of individuals with spelling difficulties and/or developmental dyslexia.

## Appendix. The items used in the study

### Nouns

T	οικόπεδο	οικογένεια	<i>ikopeΔo</i>	<i>ikoyenia</i>	<i>plot</i>	<i>family</i>
T	ανεμόμυλος	νερόμυλος	<i>anemomilos</i>	<i>neromilos</i>	<i>windmill</i>	<i>watermill</i>
T	ηχορύπανση	ηχομόνωση	<i>ichoripansi</i>	<i>ichomonosi</i>	<i>noisepollution</i>	<i>insulation</i>
T	σιδηρόδρομος	αυτοκινητόδρομος	<i>sidiroΔromos</i>	<i>aftokinitoΔromos</i>	<i>railway</i>	<i>roadway</i>
T	βιβλιοθήκη	βιβλιοπωλείο	<i>vivliothiki</i>	<i>vivliopolio</i>	<i>library</i>	<i>bookstore</i>
T	τραπεζομάντηλο	χαρτομάντηλο	<i>trapezomantilo</i>	<i>chartomantilo</i>	<i>tablecloth</i>	<i>handkerchief</i>
UN	τηλεσκόπιο	τηλεταινία	<i>tileskopio</i>	<i>tiletenia</i>	<i>telescope</i>	<i>telemovie</i>
UN	θαλασσοταραχή	θαλασσοπνιγμός	<i>thalasotarachi</i>	<i>thalasopniymos</i>	<i>sea turbulence</i>	<i>seadrown</i>
PS	οικοστέγη	οικοαυλή	<i>ikosteyi</i>	<i>ikoavli</i>	<i>houseroof</i>	<i>housegarden</i>
PS	βιβλιοκασετίνα	βιβλιομολύβι	<i>vivliokasetina</i>	<i>vivliomolivi</i>	<i>bookcase</i>	<i>bookpencil</i>

### Adjectives

T	καλοπληρωμένος	καλότυχος	<i>kalopliromenos</i>	<i>kalotichos</i>	<i>wellpaid</i>	<i>poorpaid</i>
T	πυκνογραμμένος	προχειρογραμμένος	<i>piknogramenos</i>	<i>prochirogramenos</i>	<i>tightly written</i>	<i>offhand written</i>
T	φιλελεύθερος	φιλήσυχος	<i>fileleftheros</i>	<i>filisichos</i>	<i>liberal</i>	<i>love quietness</i>
T	κακοντυμένος	καλοντυμένος	<i>kakodimenos</i>	<i>kalodimenos</i>	<i>frump</i>	<i>well-dressed</i>
T	αργοκίνητος	αργόστροφος	<i>aryokinitos</i>	<i>aryostrofos</i>	<i>slowmoving</i>	<i>slowspinning</i>
T	πολύχρωμος	σκουρόχρωμος	<i>polichromos</i>	<i>skourochromos</i>	<i>multicolored</i>	<i>darkcolored</i>
UN	κοσμοξάκουστος	κοσμογυρισμένος	<i>kosmoxakoustos</i>	<i>kosmogirismenos</i>	<i>renowned</i>	<i>globetrotting</i>
UN	χρυσόδετος	χρυσοποικιλτος	<i>chrisoΔetos</i>	<i>chrisopikiltos</i>	<i>gold-bounded</i>	<i>gold-decorated</i>
PS	σωστογραμμένος	λαθογραμμένος	<i>sostoyramenos</i>	<i>lathoyramenos</i>	<i>correctlywritten</i>	<i>wronglywritten</i>
PS	πρασινοντυμένος	κοκκινοντυμένος	<i>prasinodimenos</i>	<i>kokinodimenos</i>	<i>greendressed</i>	<i>reddressed</i>

### Verbs

T	πηγαινοέρχομαι	πηγαινοφέρνω	<i>piyenoerchome</i>	<i>piyenoferno</i>	<i>come &amp; return</i>	<i>come &amp; bring</i>
T	αναβοσβήνω	τρεμοσβήνω	<i>anavosvino</i>	<i>tremosvino</i>	<i>blink</i>	<i>flicker</i>
T	ανθοστολίζω	ανθοφορώ	<i>anthostolizo</i>	<i>anthoforo</i>	<i>flower</i>	<i>flower-blossom</i>
T	ηχογραφώ	δακτυλογραφώ	<i>ichoγrafo</i>	<i>Δaktilyrafo</i>	<i>echotape</i>	<i>typewrite</i>
T	πρωτοακούω	πρωτοδιαβάζω	<i>protoakouo</i>	<i>protoΔiavazo</i>	<i>hear first</i>	<i>read first</i>
T	στριφογυρίζω	πισωγυρίζω	<i>strifyoyirizo</i>	<i>pisoyirizo</i>	<i>spin</i>	<i>go backwards</i>
UN	μοσχοβολώ	μοσχομυρίζω	<i>moschosolo</i>	<i>moschomirizo</i>	<i>scent</i>	<i>scent</i>
UN	ηλεκτροδοτώ	πριμοδοτώ	<i>ilekτροΔoto</i>	<i>primoΔoto</i>	<i>give electricity</i>	<i>credit</i>
PS	πηγαινοαναιβαίνω	πηγαινοκατεβαίνω	<i>piyenoaneveno</i>	<i>piyenokateveno</i>	<i>go &amp; rise</i>	<i>go &amp; get down</i>
PS	πλαγιογυρίζω	κατωγυρίζω	<i>playioyirizo</i>	<i>katoyirizo</i>	<i>turn sideways</i>	<i>turn down</i>

**Prefixed verbs**

T	παραμένω	παραβλέπω	<i>parameno</i>	<i>paravlepo</i>	<i>remain</i>	<i>overlook</i>
T	περιβάλλω	αμφιβάλλω	<i>perivalo</i>	<i>amfivalo</i>	<i>be around</i>	<i>dispute</i>
T	ξεπλένω	ξεκολλάω	<i>xepleno</i>	<i>xekolao</i>	<i>rinse</i>	<i>detach</i>
T	διατηρώ	παρατηρώ	<i>Diatiro</i>	<i>paratiro</i>	<i>retain</i>	<i>observe</i>
T	υποδέχομαι	υποστηρίζω	<i>ipodechome</i>	<i>ipostirizo</i>	<i>undertake</i>	<i>support</i>
T	αξιοποιώ	παραποιώ	<i>axiopio</i>	<i>parapio</i>	<i>utilize</i>	<i>twist</i>
UN	αντιλαμβάνομαι	αντιμετωπίζω	<i>antilamvanome</i>	<i>antimetopizo</i>	<i>comprehend</i>	<i>confront</i>
UN	ανασηκώνομαι	αναστηλώνω	<i>anasikonome</i>	<i>anastilono</i>	<i>hike up</i>	<i>restore</i>
PS	υπογίνομαι	υποφτιάχνομαι	<i>ipogynome</i>	<i>ipoftiachnome</i>	<i>under-make</i>	<i>under-make</i>
PS	ξαναποιώ	μονοποιώ	<i>xanapio</i>	<i>monopio</i>	<i>re-make</i>	<i>only-make</i>

Abbreviations: T=Trained items, UN=Untrained items, PS=Pseudowords

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