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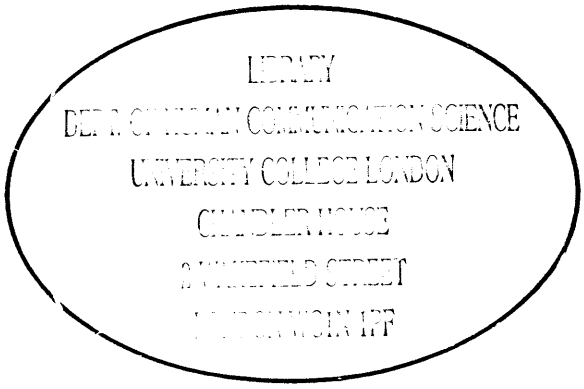
SINGLE-WORD SPELLING THERAPY: REVEALING THE POTENTIAL TO STRENGTHEN THE GRAPHEMIC REPRESENTATIONS OF UNTREATED ITEMS

GEMMA CLUNIE



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ABSTRACT

Introduction

Research into spelling difficulties following a stroke has focused on several different approaches, but one of the most successful and widely reported is that of using a therapy programme that allows a person with aphasia to relearn a limited vocabulary of spellings. This study aims to investigate the viability of this type of spelling therapy with a subject whose spelling impairments were more profound than the participants involved in previously reported case studies of a similar nature (Beeson 1999, Beeson et al 2000, 2002). The subject involved in the current study, SK, also had concomitant non linguistic impairments that exacerbated his access to therapy.

Method

A partial replication of Beeson's (1999) Anagram and Copy Treatment and Copy and Recall Treatment was used to recreate a treatment programme that was tailored to the specific difficulties shown by SK and was also more realistic for therapists within the NHS to duplicate.

Results

SK was able to relearn a very small vocabulary of spellings that suggested an item-specific treatment effect. However, closer analysis of the subject's responses to all tested items implied generalisation on a graphemic level to untreated items – for example an improved ability to correctly write the first letters of untreated words and identify the correct position of letters within an anagram.

Discussion

The strengthening of graphemic representations, even following a relatively short treatment period, provided positive evidence that spelling therapy can be an effective intervention for even the most severely affected patients. These findings also emphasise the importance of looking in-depth at spelling changes pre-and post-therapy in order to ascertain the true level of improvement, since whole word relearning does not have to be the only marker of success, especially with patients who have profound dysgraphia.

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

INTRODUCTION

There is a long precedent for developing therapy programmes for aphasia where the goal is to provide an alternative form of communication to speech. Using compensatory strategies has been shown to be an effective means of intervention (Pound, Parr, Lindsay & Woolf 2000). The flexibility of exploring various modalities such as drawing, writing and gesture as functional methods of communication has proved especially beneficial for people who have severe aphasia, since it circumvents meaningless spoken utterances (Cubelli, Trentini & Montagna 1991; Sacchett, Byng, Marshall & Pound 1999).

The use of compensatory strategies also enables therapy to focus on the strengths of an individual and is a vital intervention approach for people with chronic aphasia whose spoken ability has plateaued (Lustig & Tompkins 2002). Intervention can be adapted according to the individual taking part in the programme, using whichever communicative modality best suits their residual abilities.

In recent years an increasing amount of research has been conducted into using spelling as a strategy to overcome the communicative difficulties of severe aphasia (Beeson 1999; Beeson, Rewega, Vail & Rapcsak 2000; Beeson, Hirsch & Rewega 2002; Rapp & Kane 2002). Frequently the tasks used within therapy are well suited to those with severe difficulties since they are repetitive, undemanding and simple to adapt in order to minimize errors, for example direct copying. This is useful for people with extremely impaired language since they are able to carry out the tasks without having their confidence lessened by mistakes, but within a framework where errors can be self-corrected without directive clinician involvement (Whitworth, Webster & Howard 2005).

Studies that have focused on single word spelling as an alternative to spoken language have shown that people with severe aphasia are able to relearn a limited vocabulary of written words following therapy, even in cases where spelling was equally impaired to speech (Beeson 1999; Beeson et al 2000; Beeson et al 2002). Using both direct therapy and homework tasks is a key aspect of these studies since it ensures that the required intensity of therapy required for improvement (Bhogal,Teasell & Speechley 2003) can be achieved without an unrealistic use of clinician contact time, and therefore has the potential to be reproduced within any therapy setting.

The development of a small spelling vocabulary of single words by using repetitive, constrained therapy techniques is also of interest when broadening a patient's communicative options, since the opportunity to use various communicative modalities can expand the prospects of a person with aphasia (Rapp & Kane 2002). This is even true In the case of those people who already have a limited vocabulary of spoken words because relearning to spell these words can be functionally useful (e.g. writing shopping lists or spelling a word in cases of anomia).

This type of impairment based therapy is regarded as a constructive form of aphasia intervention (RCSLT 2005), but in order to be successful it requires a detailed evaluation of the aphasia patient's breakdown of skills and difficulties. A clinician must use a particular framework so as to define their patient's individual areas of strength and weakness. In other words, before making a decision regarding which therapy approach would be most effective for an individual patient, the clinician should first evaluate the areas of language processing skills that have remained intact post-stroke, including the spelling processes that are available to them.

The cognitive neuropsychological framework of normal language processing, such as that described in Ellis & Young (1988) and Whitworth et al. (2005), has been used in recent dysgraphia research, including Beeson (1999). By defining the normal system of language processing as modular, with various sub-components responsible for different aspects of the production and comprehension of speech and spelling that can each be damaged independently of the others, this approach allows the difficulties of each person to be explained individually. This prevents the need for basing therapy on the syndrome-based system that does not allow for the heterogeneity of aphasia (Poeck 1983).

The Cognitive Neuropsychological Theory of single-word spelling

The model illustrated in Figure 1 shows the sub-components involved in single word spelling. In normal conditions there are three possible routes for spelling tasks: the semantic lexical route; the sub-lexical route and finally the direct lexical route (Whitworth et al. 2005).

Semantic-lexical Route

This route is so called because lexical items – words – are activated within the framework due to their meaning. The stimulation of the semantic information for a specific word in turn activates the abstract entry within the orthographic output lexicon[1]. This lexicon can be described as the store for long-term learned spellings. The appropriate letter strings are held within the graphemic output buffer and then converted into allographs, allowing for the final motor processes necessary to formulate each letter correctly.

Sub-lexical Route

Unfamiliar or non-word items that do not have entries within the lexicon cannot be spelled by the above method. These words must therefore be spelled by using phonological to graphemic conversion, i.e. a heard word must be separated into phonemes, which are then converted into graphemes in order to achieve a credible spelling.

Direct Lexical Route

The third route that is available to a person spelling single words in normal circumstances can only be used for the spelling of recognized and real words. It involves a person identifying the phonology of a heard word from the phonological output lexicon and then matching this item to an entry within the orthographic output lexicon, thereby bypassing semantics.

[1] The orthographic output lexicon can be interchangeably referred to as the graphemic output lexicon, similarly the graphemic output buffer is also known as the orthographic output buffer.

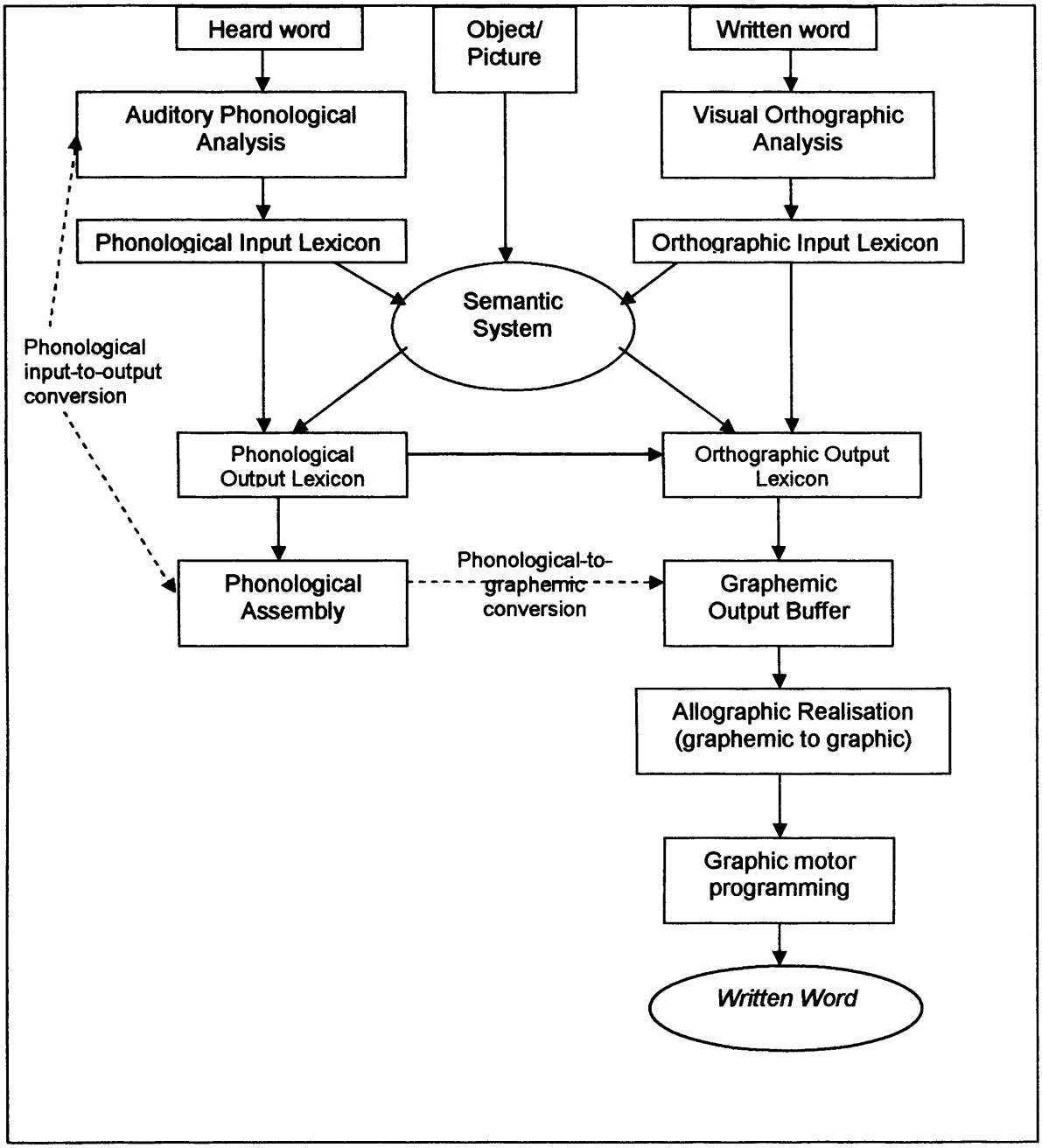


Figure 1: A cognitive neuropsychological model of single-word spelling taken from Whitworth et al. (2005)

Empirical research using case study data from patients with dysgraphia following neurological damage has provided strong evidence for the separation of the spelling process into the three routes described above (Beeson et al 2000, Goodman & Caramazza 1986, Ellis & Young 1988). It has also led to the classification of three sub-types of acquired spelling difficulty: deep dysgraphia, caused by spelling via an impaired semantic lexical route; surface dysgraphia, resulting from impaired lexical information but residual phoneme-to-grapheme conversion ability and phonological dysgraphia due to difficulty with sub-lexical spelling

(Whitworth et al. 2005). It is also possible to identify whether spelling difficulties lie in more peripheral areas which do not result in a clear-cut spelling difficulty – for example an impaired graphemic output buffer would impact on all three of the possible routes for spelling and may cause a more extensive spelling impairment – a type of "global dysgraphia" (Beeson & Hillis 2000).

The internal organisation of the sub-components within the framework has been subject to research as well. For example, the form of graphemic representations held within the graphemic output buffer has been investigated (Wing & Baddeley 1980, Buchwald & Rapp 2003), and recent studies have suggested that the nature of these representations is multidimensional. This means that different aspects of a graphemic representation – the orthography – for example the first letter of a word or a double letter within a word, are encoded separately (Tainturier & Caramazza 1996). This theory implies that looking at the graphemic composition of the spellings of those with dysgraphia could help to localise the processing impairment.

This research supports the notion that following neurological damage, independent sections of the spelling process can be damaged whilst others are left intact. Therefore, in theory a clinician should be able to perform a battery of assessments in order to isolate the specific nature of a patient's impairment allowing them to choose the most relevant therapy plan and utilise their preserved abilities. However, even when working within a cognitive neuropsychological framework and evaluating an individual and unique pattern of strengths and deficits, clinicians must retain an open mind when considering therapy approaches and continually re-evaluate their client's needs (Beeson et al. 2000, Rapp & Kane 2002).

This is particularly true when working with patients who suffer from severe aphasia, since it is likely that the neurological damage will be diffuse enough to have affected all components of the spelling process to various degrees, rendering isolation of the specific areas of breakdown impractical (Beeson 1999). Despite the difficulty of using a cognitive neuropsychological framework in order to assess the capabilities of a person with severe aphasia, it is still a valuable tool which guides therapy towards areas that are more receptive to improvement. It is also vital when evaluating success post therapy in order to gain further information about a client's processing skills and impairments. This allows the clinician to refine their pre-therapy hypotheses and progress with therapy accordingly (Beeson et al 2002).

The cognitive neuropsychological framework is therefore a useful tool for evaluating spelling difficulties following neurological injury, but it is pertinent to clarify that it has been developed to be used as tool to analyse English and the specifics of its orthography – both irregular and regular. Since languages are diverse entities that differ in many ways from each other, for instance phonologically and orthographically, they each need to be considered from a language-specific framework (Hamers & Blanc 2000). This is significant for those clinicians who work with bilingual patients, since whilst they may be conducting therapy in English, they will need to take into account the potential for disparity between the cognitive neuropsychological framework of a monolingual person with aphasia in comparison to that of a polyglot aphasic (Luelsdorff & Eyland 1991). For those patients with spelling difficulties this could make identifying specific breakdowns even more complicated.

Nevertheless, a cognitive neuropsychological framework remains an excellent starting point when choosing a therapy approach that best suits the spelling difficulty of an individual client. It is possible to focus on the semantics of a word and the relationship to the word form, for example using spelling tasks that are complemented by word-to-picture matching activities, as described by Robson, Pring, Marshall, Morrison and Chiat (1998). This method aims to strengthen the lexical-semantic route to spelling. Conversely, other treatment studies have been developed to strengthen sub-lexical spelling by building on phoneme-to-grapheme conversion skills (Hillis and Caramazza 1994).

However, as has been discussed, it is common that people suffer impairments to more than one of the possible routes for spelling, therefore therapy approaches are required which bolster the interaction between these different routes. Beeson et al 2000 worked with two clients – SV and SW – whose spelling performance reflected damage to both lexical and sub-lexical routes. During treatment SW and SV were encouraged to use strategic methods such as self-correction, sound to letter correspondence and an electronic spellchecker to work on their spelling at home, and were both given support and feedback during therapy sessions. Both patients exhibited improvement following therapy and this study was successful in implementing a functional way of broad spelling improvement. In cases of severe neurological impairment this method would be inappropriate for use since it requires a high level of self-awareness to participate in the self-directed therapy and the ability to access information from

multiple spelling routes. Patients with severe language difficulty would be unable to achieve this, and a simpler, item-specific approach is more valid.

When working on severe spelling difficulties in an item-specific way, focusing on strengthening the graphemic representations within the orthographic output lexicon and graphemic output buffer has been a useful therapy approach. One method was developed by Beeson (1999) and used with ST, described as having severe Wernicke's aphasia following a CVA. Following assessment Beeson was unable to identify the specific areas of impairment that contributed to ST's spelling difficulties, but impairment to graphemic representations and the graphemic buffer were hypothesized.

Beeson's therapy used a cueing hierarchy, known as Anagram and Copy Treatment (ACT), within the contact therapy sessions between the clinician and ST. Single words that had functional relevance to ST were selected in the hope that improving his spelling of these items would have an impact on his overall communication. By using the repetitive tasks of uncued written naming, anagram spelling, repeated copying and delayed recall it was hoped that ST's graphemic representation of each of the treated words would be strengthened.

This process was supplemented by homework consisting of daily copying tasks involving the targeted words (Copy and Recall Treatment – CART) in order to maximise opportunity for improvement and allow the patient to take a direct role within their own therapy – a factor that has been shown to enhance therapy effectiveness (Hillis 1998).

Following therapy sessions ST was able to relearn the spellings of treated items, but this did not generalise in any way. Further development of the sixteen month long therapy programme to include phases of a purely CART based homework task, conversational exchanges and items chosen for therapy by ST himself were all successful in allowing ST to relearn a vocabulary of spellings – provided the words had been targeted in therapy. Thus, the conclusion was drawn that several different therapy approaches had helped to strengthen item-specific graphemic representations and gave ST an alternative form of communication to his severely impaired spoken utterances.

The success of this therapy was explored further by Beeson et al (2002), who investigated the use of both ACT and CART therapy with a further two subjects, and CART homework tasks

with two others, over a period of three months. The item-specific single word spelling abilities of all four subjects were improved following therapy, without generalisation to untreated items but with anecdotal evidence that the therapy had a spontaneous, functional impact on all four patients. The three most severely affected patients were able to use their newly learnt vocabulary of words in order to help their functional communication, and the fourth participant re-accessed the ability to use e-mail.

Thus these treatment studies have shown that it is possible to improve single word spelling difficulties by working on strengthening graphemic representations, even when patients have chronic, severe aphasia. However, whilst these studies achieve change and advocate the undemanding nature of the therapy, the timeframe within which they achieve results is unrealistic to recreate within the current NHS.

They also require a significant amount of concentration and self-directed practice from subjects. This may be impractical considering that following neurological injury people are often left with attention difficulties and emotional problems that interact with severe language difficulties and require adapted therapy programmes to take account of these obstacles.

This research has focused on developing a written vocabulary to supplement empty spoken utterances following a regimented treatment process. An area of investigation that is lacking from current research is whether a person suffering from profound aphasia, who may not be able to relearn the spellings of a large vocabulary of single words, is able to show any kind of improvement. For example, even if accurate whole word spelling is not achieved, the clinician could analyse the number of correct letters their patient is able to produce, thus revealing strengthened graphemic representations. The improvement would still be functionally relevant to a severely impaired subject since they could gradually build on spelling accuracy for a small communicative vocabulary without achieving complete success. This is not considered in much research of this kind (Beeson 1999, Beeson et al 2000, 2002) and is a potential area of development.

The Current Study

The current study ventures to investigate further the potential benefits of strengthening graphemic representations by using a hierarchical cueing system and copying treatment. The study aims to investigate the following questions:

The technique of using a hierarchy of cues and copying treatment with people who have severe spelling difficulties has proved successful, but will a similar programme improve single word spelling on treated words for a subject who has profound dysgraphia?

Do improvements on treated words generalise to untreated words?

How will spelling improve? For example will pre- and post-testing show strengthening of graphemic representations by analysing the number of letters correctly recalled in the uncued writing task, or correctly positioned in the anagram task, and does this generalise to untreated items?

Will single word spelling improve within a short, five week, therapy programme designed for a participant with profound spelling difficulties compared to that originally devised by Beeson (1999)?

The current study is a partial replication of Beeson's (1999) procedures with adaptations (see Method) put in place to account for the differences between her participant and the current subject.

METHOD

This study employs an ABA single case therapy design. Pre-therapy assessment was followed by a therapy phase. Performance was then re-assessed post-therapy. The study was designed to investigate item-specific treatment effects and generalisation to untreated items.

Case Description

SK is a seventy-four year old gentleman who suffered a left-sided CVA of the middle cerebral artery in December 2000. Following his stroke SK was left with mild to moderate receptive aphasia and severe to moderate expressive aphasia exacerbated by a degree of dyspraxia and hearing loss. The stroke also resulted in short term memory difficulties and a right-sided hemiparesis.

Prior to his stroke, SK was a managing director of a construction company based in London. His first language is Serbian, but before suffering his CVA he was fluent in English, Italian, Russian and French. SK has always requested assessments and therapy to be carried out in English, since his primary language had been English and he continues to live in an English-speaking environment. He lives alone in sheltered accommodation but his partner and daughter also live in London and he has a carer who visits twice a day.

In the six years following his stroke SK has received several programmes of therapy. These have included dyspraxia therapy, focus on single word output, trial and rejection of a communication aid and extensive work on functional communication using a communication book, interactional drawing and working both with SK's daughter and his carer on developing supported conversation strategies.

A modified programme of Copy and Recall Treatment (CART) therapy had been carried out with SK a year and a half prior to this study with limited success. Therapy sessions had not been consistent, and the treatment regime was discontinued before significant gains had been made.

At the time of the present study, he was participating in group therapy. SK was able to use Total Communication strategies such as gesture, facial expression and drawing to facilitate

everyday conversation and used his communication book when prompted. He remains motivated to achieve the progress in his communication skills; however the CVA also resulted in limiting factors including emotional lability and limited concentration.

SK would often write numbers to indicate dates and ages, and was able to write the first letters of his name, but unless given a lot of prompting rarely used writing in a communicative way. Informally he showed no evidence of converting from phoneme to grapheme, although this observation was complicated by his polylingualism and the difference between the Serbian and English alphabets. Following a range of assessments to evaluate SK's language abilities, spelling therapy was seen to be an appropriate approach to build on SK's Total Communication skills.

Language Processing Skills

Comprehension

The results from the input tests conducted with SK are reported in Table 1. His performance on the three picture Pyramids and Palm Trees test was within normal limits, indicating that SK's central semantic processing is a relative strength following his stroke, but SK was less successful on the PALPA spoken and written word-to-picture matching tasks, although he performed above chance in both tests. This indicated that SK's verbal input channel is more impaired than his visual input channel; although his errors did not reveal any clear patterns. It is also pertinent to note that despite SK's difficulty perceiving certain auditory stimuli during testing due to his hearing impairment, his auditory input channel was still stronger than his written channel.

SK found the more complicated tasks of auditory and written synonym judgments extremely difficult and both tests had to be abandoned due to his frustration and distress. SK's struggle with this test confirms the finding that his comprehension difficulties are due to more peripheral impairments; but despite his difficulties with these complicated tests SK has good functional everyday comprehension skills.

TABLE 1: Results of Comprehension Tests

Pyramids and Palm trees Test (3 picture version)	50/52 (WNL)
Spoken Word- to- Picture Matching	34/40

(PALPA 47)	Errors: 1 close semantic 1 distant semantic 1 visual 1 no answer
Written Word-to-Picture Matching (PALPA 48)	31/40 Errors: 4 close semantic 2 distant semantic 3 unrelated
Spoken Synonym Judgment (PALPA 49)	2/20 (abandoned)
Written Synonym Judgment (PALPA 50)	1/8 (abandoned)

Spoken Output

The results from the output tasks conducted with SK are reported in Table 2. His performance on all three tests of verbal naming indicated a severe breakdown in the verbal output channel. SK was noted to frequently give the Serbian name for a picture but be unable to retrieve the analogous word in English, despite being aware that he had named in the wrong language. Phonemic cues were observed to be the most effective cueing strategy to elicit a response from SK, but he often struggled not to perseverate on previous responses.

TABLE 2: Results of Spoken Output Tests *

Spoken picture naming (PALPA 53)	5/40	Phonemic cues most helpful to elicit response
Action Object Naming Battery (Object List A)	13/80	With phonemic cues was able to name more than 13
Action Object Naming Battery (Action List B)	3/50	Occasionally gave noun instead of verb e.g. watering → water

* SK often gave Serbian name, without being able to access English

Written Output

SK had shown the ability to use writing in conversation, especially in order to communicate numbers, dates or the first letter of words to a communication partner. A copying task confirmed the necessary motor skills for spelling were intact, despite the necessity of writing with his non-dominant hand.

SK was unable to spell highly imageable short single words from dictation, for example *bird* (see Table 3). He found the task extremely difficult and on several occasions would not even guess at the first letter. Since comprehension tasks had pointed to one of SK's relative strengths as being his auditory input channel, his difficulties on this task indicated a severe deficit in the written output channels. To gain further information about SK's spelling difficulties the task was adapted into a letter by letter dictation task. SK was equally unable to achieve success in this task. It was apparent that SK had difficulty with all written output channels, but specifying the impairments was difficult.

TABLE 3: Results of Written Output Tests

Spelling to Dictation	0/10	SK was unable to spontaneously spell spoken words
Letter By Letter Dictation of Words	0/10	Unable to understand English letter names With Serbian alphabet was able to achieve limited success (pronunciation = different t English letter names)
Copying task	10/10	No difficulties.

Adaptations to the Current Study

The first variation from the original Beeson study (1999) is that the third step of her study – involving the use of foil letters in a second anagram task – has been omitted. Secondly, the design of the current study involved linear progress from step to step, without any return to earlier stages. Finally, the participant was only asked to try and recall the word twice. Irrespective of whether he was successful or not, after the second time, the therapist moved on to the next word. The rationale for these changes was due to several factors.

The subject in the current study was emotionally very labile, and became very frustrated by failure. Since participant motivation is a key aspect of successful therapy (Whitworth et al. 2005) it was felt that an adapted design with more chance of success, and less focus on a flawless performance for each item, every session would be more appropriate. This also shortened the therapy time, which helped to maintain maximum concentration from the participant at all times. The changes were also considered to be useful to ascertain whether improvement on single word spelling was possible with a shorter, more flexible therapy programme.

The Therapy Study

Stimuli

The therapy stimuli consisted of thirty words selected according to their functional communication relevance to SK. These words were separated into two sets of fifteen words. The two sets were matched for overall word length, frequency and category; noun, verb and adjective, but the major consideration was that they were of functional relevance (Appendix 1).

The first set of words was designated as the Therapy Set, for the therapist-guided programme including homework tasks. The fifteen words in the Therapy Set were those that could be selected for treatment. The Therapy Set of words was further divided into three sets of five (Set 1, 2 and 3), fairly equal in terms of length, frequency and category (Appendix 2). This separation was carried out due to SK's limited concentration and frustration at his language abilities. It was felt that working on five words in therapy at a time would be more productive for SK's potential to improve. A criteria was set that were SK to successfully spell a word from Set 1 for two therapy sessions in a row, this would be replaced within the therapy sessions by a word from Set 2 or 3 that was a similar length so that at any given point SK was working on five words of varying length.

The second set of words was used as a Control Set and was not practised in any way between pre- and post-therapy testing.

Pre-Therapy Testing

The thirty words chosen for use as the Therapy and Control Set of words were all tested pre-therapy with a baseline test that comprised three different levels, using previously introduced line drawings as stimuli. These levels were:

a) **Uncued Written Naming** – SK was asked to spell the name of each of the thirty selected words from a picture, and was offered no cues to support his writing
b) **Anagram Spelling** – SK was given the appropriate Scrabble tile letters for each of the thirty words and asked to rearrange them into the correct spelling of the word
c) **Uncued Spoken Naming** – SK was asked to spoken name each of the thirty stimuli pictures, without being offered any cues.

SK was asked to complete each of the three levels for each picture before moving on to the next. The first two levels were used to establish a baseline score that showed SK's graphemic

knowledge surrounding each word before therapy was started. The third level was carried out in order to compare SK's verbal output for each word with his written naming. SK was also asked to copy each of the thirty words in order to ensure he had no difficulties with his motor spelling skills in relation to each of the stimuli.

Therapy

SK participated in a five week period of therapy. The therapy consisted of 12 hour-long sessions where the therapist conducted a guided programme of written naming intervention. In between each direct therapy session SK was asked to complete copying homework for each word.

The first set of five therapy words was presented to SK as two pages of stimulus line drawings; three on one page and two on the other, each with a separate response sheet. The response sheet was separated into five sections, one per picture. A grid for each word showing the number of letters needed for the response was reprinted five times in each of the separate sections (see Appendix 3).

The therapy procedure for the therapist-directed programme was identical each week, including the order in which each of the words was presented. This was to ensure that SK became comfortable with the therapy process, in order to make it a positive experience for him. The stimulus picture was uncovered and SK was asked to write the word in the first grid on the response sheet – this was equivalent to an uncued written naming task. If he was successful, the next picture was uncovered, and therapy moved on. However, if SK was unsuccessful, he was given the Scrabble tiles which matched the letters he required to spell the word. He was then asked to sort the letters into the correct order – a naming task using anagram sorting. If he could not do this after three attempts the therapist rearranged the letters for him. SK was then asked to copy the word three times. All written instances of the word were then covered over and SK was asked to try and write the picture name from memory. If he was successful the therapy moved on to the next target word. However, if SK was unsuccessful, the therapist uncovered the written word and SK was asked to copy it once more. The process of covering all written examples of the word was then repeated and SK was asked to recall the spelling once more. At this point therapy always moved on to the next word whether he was successful or not due to SK's low frustration threshold.

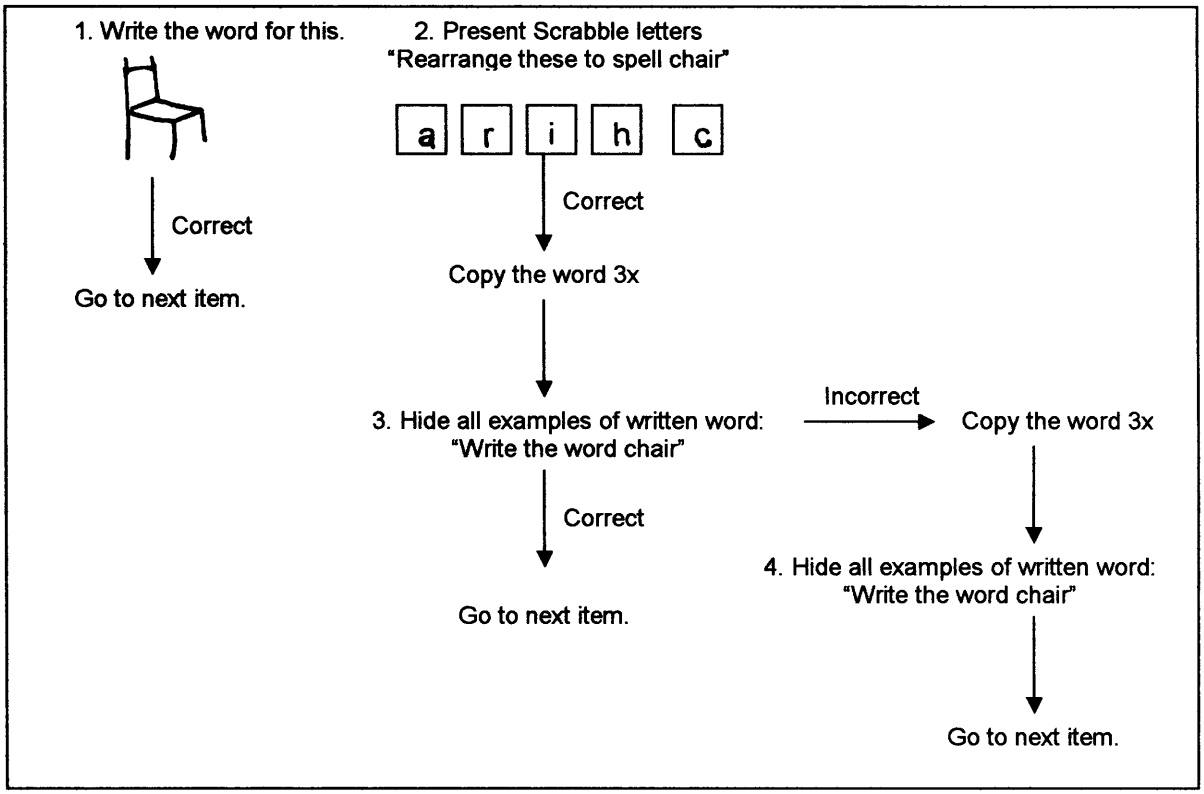


Figure 2: Graphic representation of the revised Anagram and Copy Treatment (ACT) based on the original design by Beeson (1999)

In this therapy procedure the therapist was able to offer SK constant feedback about his performance. His frustration was minimised by the use of motivating comments such as "you've got the first letter right, can you think of any others?" and spoken repetition of the picture name. When SK was struggling, his attention was drawn to letters which required correction and also accurate aspects of his performance at all levels of the task. Occasionally, SK would require re-focusing on the task due to his tendency to become distracted or perseverate on previous words. This was achieved by repetition of the appropriate stimuli and constant familiarisation with the task and picture. At the end of each therapy session SK and the therapist would compare his performance with the previous session and discuss which words were easier or more difficult and the potential reasons for this.

When SK was able to uncued written name a word for two therapy sessions in a row this word was replaced with a word from Set 2 or Set 3 of the Therapy Set words. The replacement was chosen as the closest match for the variables of length, category and frequency. The word that was no longer targeted in direct therapy continued to be targeted in the homework task in order to maintain SK's progress.

The homework task was always assigned at the end of each session and SK's attention was drawn to the potential benefits of copying practice in order to achieve maximum progress in the therapy sessions.

SK was given copies of the picture stimuli with the picture on one side and a written example of the word on the other. He was asked to copy each word four times below the written example and this was consolidated by the written instruction of Copy x 4 underneath each picture.

Post-therapy Testing

SK was re-tested a week after the twelfth therapy session on all three of the original tests – Uncued Written Naming, Anagram Spelling and Uncued Spoken Naming results were collected for all thirty of the original words from both the Therapy and Control groups of words.

Scoring

Several sets of scores were collected. Firstly, SK's performance on the three pre-therapy and post-therapy tests of uncued written naming, anagram naming and uncued spoken naming was obtained in order to compare and consider any overall improvements on a whole word level.

Secondly, SK's performance was monitored during each therapy session by recording the number of whole words produced per session and the stage of therapy that they were accurately recalled, i.e. the uncued written naming stage, the anagram sorting stage, recall 1 or recall 2.

Finally, SK's performance pre- and post- therapy at a graphemic level was also recorded. The number of letters correctly remembered, and their position in the word was also monitored by using a grid system that mirrored that used by SK during therapy. This allowed the therapist to analyse patterns of recall throughout the programme and also to evaluate SK's improvement in terms of numbers of letters recalled correctly and in the correct positions.

RESULTS

During the 12 sessions of therapy SK received treatment for eight words from the potential fifteen words in the Therapy Set. SK found therapy very difficult, and was therefore only able to achieve the correct uncued written spelling of three words in two consecutive sessions. There were 22 untreated items (15 from the Control Set and seven from the Therapy Set). Since SK's spelling of both the words from the Control Set and the untreated items in Therapy Set was very poor both pre- and post-therapy their results have been combined. Test scores have therefore been given for a comparison between 22 untreated items and eight treated items in order to give an accurate representation of therapy effects.

SK's progress on each of the four therapy conditions is recorded in Figures 3-6. These show that although the pattern of improvement is uneven in each of the conditions there is a definite positive change over the course of the 12 sessions. The arrows on each of the graphs indicate the week at which a new word was added and the ensuing change in ceiling results available to SK.

FIGURE 3: Week by Week Progress of Uncued Spelling

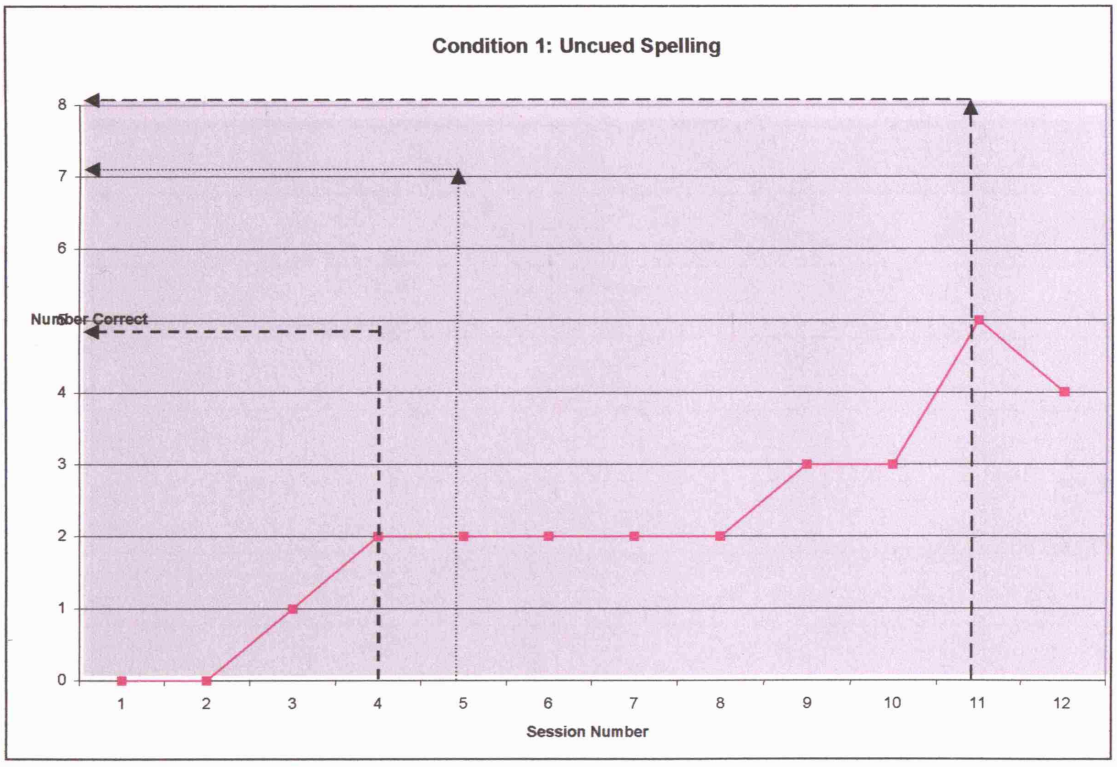


FIGURE 4: Week by Week Progress of Cued Anagram

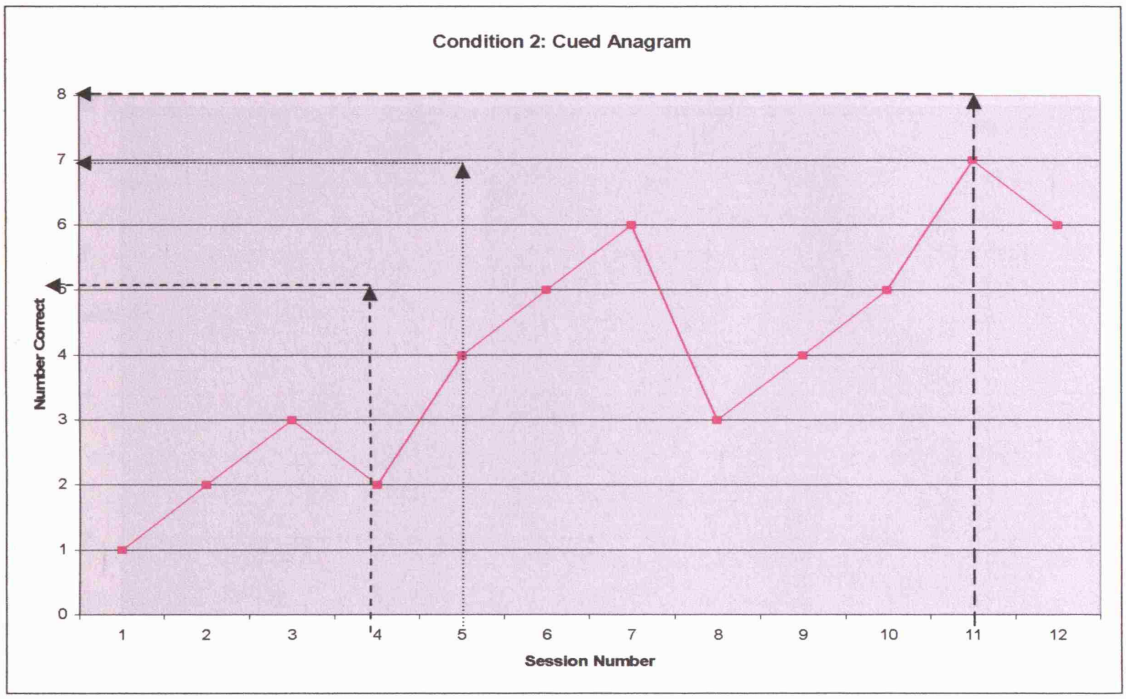


FIGURE 5: Week By Week Progress of Delayed Recall (Attempt 1)

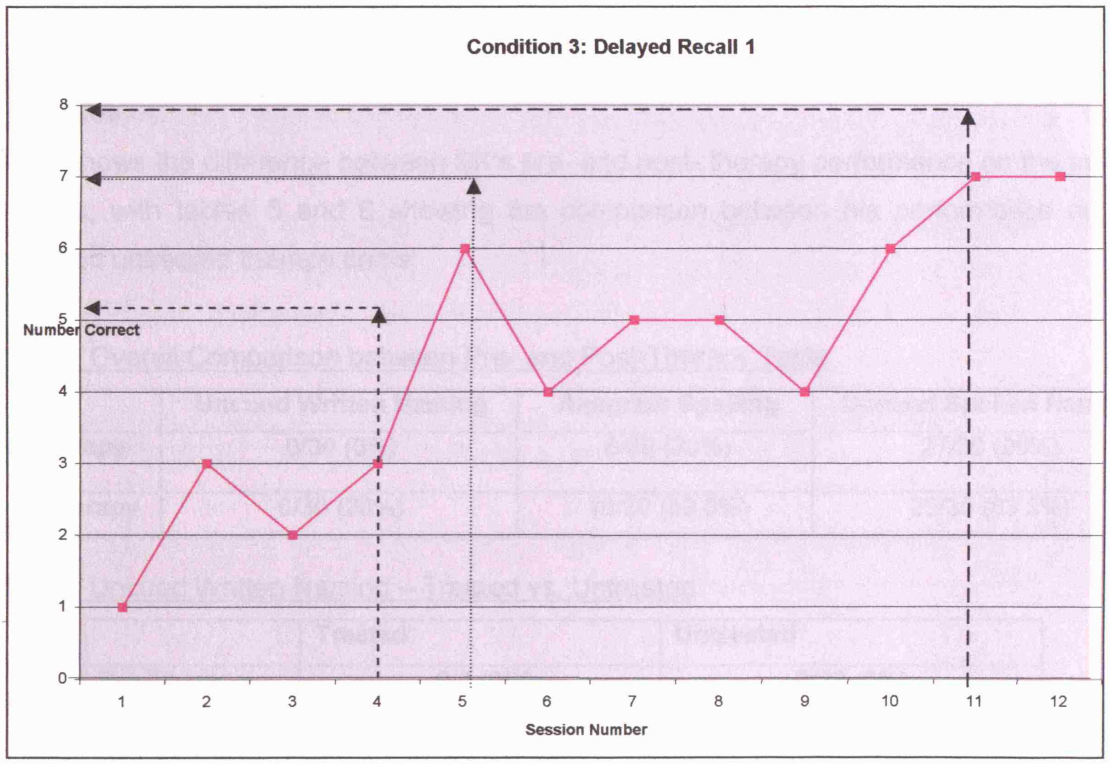
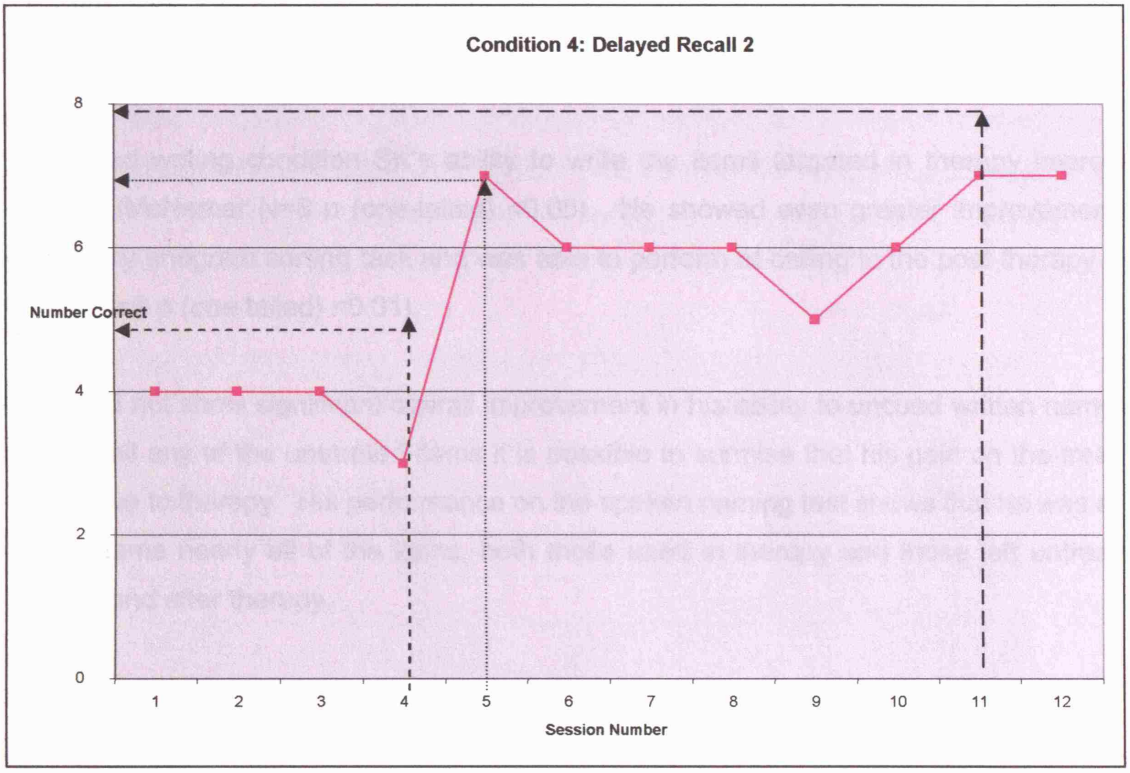


FIGURE 6: Week by Week Progress of Delayed Recall (Attempt 2)



Test Scores

Table 4 shows the difference between SK's pre- and post- therapy performance on the testing conditions, with tables 5 and 6 showing the comparison between his performance on the treated and untreated therapy items:

TABLE 4: Overall Comparison between Pre- and Post-Therapy Tests

	Uncued Written Naming	Anagram Spelling	Uncued Spoken Naming
Pre-Therapy	0/30 (0%)	6/30 (20%)	27/30 (90%)
Post Therapy	6/30 (20%)	16/30 (53.3%)	25/30 (83.3%)

TABLE 5: Uncued Written Naming – Treated vs. Untreated

	Treated	Untreated
Pre-Therapy	0/8 (0%)	0/22 (0%)
Post-Therapy	6/8 (75%)	0/22 (0%)

TABLE 6: Anagram Test – Treated vs. Untreated

	Treated	Untreated
Pre-Therapy	2/8 (0%)	6/22 (27.2%)
Post-Therapy	8/8 (100%)	8/22 (36.4%)

In the uncued writing condition SK's ability to write the items targeted in therapy improved significantly (McNemar N=8 p (one-tailed) <0.05). He showed even greater improvement in the naming by anagram sorting task and was able to perform at ceiling in the post-therapy test (McNemar N=8 p (one tailed) <0.01).

Since SK did not show significant overall improvement in his ability to uncued written name or anagram spell any of the untreated items it is possible to surmise that his gain on the treated items was due to therapy. His performance on the spoken naming test shows that he was able to spoken name nearly all of the items, both those used in therapy and those left untreated both before and after therapy.

Letter Recall and Letter Position Knowledge

More detailed analysis of SK's pre- and post-testing performance reveals several interesting changes. Although SK was only able to spell 6 of the 8 treated items correctly in the post-test for uncued written naming, he was only incorrect by one letter for both misspelled words: IDEA → ITEA and FRIEND → FRIENR. Qualitatively this suggests that he had made considerable gains on his retention of the graphemic representation of both of these words, despite not spelling them completely accurately. By comparing the number of letters SK was able to recall in the uncued written naming pre- and post-therapy (Table 7), it is possible to see that he has made a significant improvement (Wilcoxon Signed Ranks Test Z=-2.54 p (one-tailed) <0.01).

TABLE 7: Uncued Written Naming – Number of Letters Correct in Treated Sample

	CHAIR	PILLOW	COFFEE	EAT	WHISKEY	HOT	FRIEND	IDEA	TOTAL
Pre-Therapy	2	0	2	0	1	2	1	0	8/40 (20%)
Post-Therapy	5	6	6	3	7	3	5	3	38/40 (95%

This indicates that therapy was beneficial, despite SK's difficulties, for all treated items, not simply those that he was able to spell perfectly in the post-test.

One of the most startling results derived from analysis of SK's performance comes from comparing the number of letters he recalled correctly for the untreated sample in pre- and post-testing. SK made a significant improvement in his ability to recall letters from the correct spellings of the untreated words (Wilcoxon Signed Ranks Test Z= -2.49 p (one tailed) <0.01). This analysis suggests that whilst SK's single **whole** word spelling did not generalise to untreated items, the therapy had some effect in strengthening the graphemic representations of all tested words (see Table 8.)

TABLE 8: Uncued Written Naming – Number of Letters Correct in Untreated Sample

Word	Pre-therapy	Post-therapy
JACKET	0	1
LIGHT	2	1
BOOK	1	1
TABLET	1	1
SOCKS	1	1
HUNGRY	0	0
HAPPY	0	1
SAD	0	0
DRINK	0	1
FOOD	0	2
YESTERDAY	0	0
BED	0	0
SLEEP	1	2
TEA	0	1
TISSUES	0	0
COLD	1	2
SERBIA	1	2
DAUGHTER	1	1
SISTER	1	1
PHOTO	0	0
HOLIDAY	0	2
BRANDY	0	0
Total	10/118 (8.5%)	20/118 (16.9%)

More detailed analysis of the Anagram Spelling test for untreated items also showed significant improvement in SK's ability to identify the correct position of letters within each tested word (Wilcoxon Signed Ranks Test Z = -1.77 p (one-tailed)<0.05). For example, pre-therapy SK arranged the anagram for SERBIA as SB and then gave up. Post-therapy he arranged the letters as SERIBA. He refused to attempt the arrangement of HOLIDAY pre-therapy, but when tested again post-therapy gave the response HODILAY. This indicates that SK's overall access to his graphemic representations was strengthened by therapy, despite this not being extensive enough to show significant changes at whole word level.

Double Letters

In the Anagram Spelling task pre-therapy SK had shown some awareness of double letters present within words, since he produced six (75%) of the eight possible double letters (from all 30 words). This knowledge was not reflected in the Uncued Written Spelling Task where SK was unable to produce any of the double letter units.

Two of the treated words had double letters – PILLOW and COFFEE. During therapy SK only separated these double letters once – in the second therapy session during the anagram stage: PILLOW → LOILPW. At all other times, he kept the LL, FF and EE together.

Post-therapy, SK had made positive gains in his ability to recall double letters within words in both his uncued written naming and anagram spelling. He was able to identify 100% of the double letters in the anagram task (for treated and untreated words), and 37.5% (3/8) of the double letters in the uncued writing test. Whilst these gains were made from a very small set of stimuli they are worth noting since they provide further information about the coding of SK's graphemic representations (see Table 8 for pre- and post- comparison).

TABLE 9: Double Letter Production

	Double Letters: Written Test	**Double Letters: Anagram Test**
Pre-Therapy	0/8 (0%)	6/8 (75%)
Post-Therapy	3/8 (37.5%)	8/8 (100%)
Difference	3 (37.5%)	2/8 (25%)

DISCUSSION

The aim of this case study was to investigate several questions. The first was to discover whether the technique of using a hierarchy of cues and copying treatment would improve single word spelling on treated words for a subject who has profound dysgraphia, as compared to previous findings by Beeson (1999) using a similar programme with a less impaired participant. Following the post-therapy testing it was clear that SK had made a significant improvement in his ability to write treated single words, supporting the hypothesis. It is possible to speculate that the repeated exposure to the words strengthens the graphemic representations by continually activating the word's entry in the orthographic output lexicon, similar to the findings of Rapp and Kane (2002).

A secondary implication of this improvement is that both the therapist-led and homework therapy elicited this change. SK was able to maintain his ability to uncued spell the words that were targeted only in homework tasks once he had achieved consistent success in therapy sessions (COFFEE, EAT and HOT). This suggests that single word spelling therapy can be a time-saving approach for those therapists whose clients are motivated enough to complete homework tasks and supports the findings of previous research studies (Beeson 2002).

It is important to note that this case study involved a subject with much more significant spelling deficits than those discussed in previous studies (Beeson 1999, Beeson 2000, Rapp and Kane 2002). Whilst this meant that fewer words were treated within therapy than had been hoped, the improvements made by the subject indicated that spelling therapy can be effective even in cases where spelling is extremely impaired, the subject is several years post-onset and has reached a plateau in communicative modalities. This substantiates findings by Lustig & Tompkins (2002), but also takes the conclusions a stage further. SK was able to spoken name all thirty of the words involved in the study. However, he had limited functional spoken output and therapy for this was no longer eliciting change. However, since spelling therapy was successful, it could be put forward that with further treatment SK would develop a larger spelling vocabulary of single words that gave him a choice of communication modalities by allowing compensation for words he was unable to name – something which could provide more "connectedness" (Lyon 1999).

The second consideration of this study was to discover whether gains on treated words would generalise to untreated items. As expected, and as has been discussed in similar studies (Beeson 1999, Beeson et al 2000, 2002) this improvement did not generalise to the untreated words used as controls, since SK was unable to accurately spell any whole words other than those that had been targeted in therapy. This item-specific relearning of single word spelling implied that therapy had only had an impact on SK's graphemic representations of the eight treated words, without altering any other aspect of his communicative abilities. The limitations of item-specific improvement has long proved a difficulty to therapists working with aphasia patients, and generally requires a large number of words to be targeted in therapy in order to recreate a functionally useful vocabulary (Beeson 1999). In SK's case, whilst functional value had not been a principle aim of the case study the likelihood of an item-specific improvement led to the selected words (both Control and Therapy Sets) being of relevance to SK's daily life, in order to maximise the potential for him to benefit practically from therapy.

However, the third question that was explored within this case study involved how SK's spelling would improve both for treated and untreated items and whether strengthening of graphemic representations could be shown by analysing the number of letters correctly recalled in the uncued writing task, or correctly positioned in the anagram task. Results from pre- and post-testing provided a positive response to this question, since SK was able to recall more letters correctly post therapy in the uncued writing test, and place letters in the correct position in the anagram spelling task, yielding statistically significant improvements for both in relation to untreated items as well as treated.

This is an extremely interesting finding, since other studies of this kind (Beeson 1999, Beeson et al. 2000, 2002) have not conducted such detailed analysis, and have therefore concluded that generalisation has not occurred. In this study there is the intimation that generalisation on some level has taken place, and that therapy – whilst only item-specific in terms of whole words – has created an overall strengthening of graphemic representations.

Interestingly, the difference between SK's pre- and post-testing ability on uncued written naming was mainly due to his improved capacity for providing the first letter of each word (50% accuracy post-therapy). This finding intimates that SK's retrieval of letters in word-initial position had been enhanced within therapy, supporting the notion that graphemic representations have a multidimensional encoding (Buchwald & Rapp 2003). Without more

detailed investigation it is impossible to discern the reason for this improvement but one theory could be ventured. The change could suggest that therapy had impacted on SK's phoneme-to-grapheme conversion route to spelling, which he did not use effectively prior to therapy. During therapy sessions SK was observed to repeat the target word several times, a tactic that he also used in testing. It is possible to tentatively link this repetition to a burgeoning ability to identify the first letter of the word from the auditory stimuli of the phoneme. The reason that a lexically-based therapy programme would have an impact on the sub-lexical spelling route is not clear, but since SK had such a severe spelling deficit it may be that therapy strengthened the specific graphemic representations, but also began to have a wide-ranging ameliorative effect on the overall spelling system.

SK's improved ability to reproduce letters in the correct position during the anagram spelling task gives further information about the encoding of his graphemic representations. It also provides support for the notion of a multidimensional graphemic representation which allows spellings to be encoded as strings of letters in a specific order (Wing & Baddeley 1980). This means that therapy to improve access to these representations may do so by making the overall orthography of the word available. Thus when SK was given the Scrabble letters he was able to access reinforced graphemic representations for both treated and untreated words and was able to more accurately identify the correct positions for the letters.

Both these generalisation effects require a significant amount more investigation in order to draw any strong conclusions, but they offer a more positive account of the potential for item-specific therapy to generalise to untreated items than has previously been allowed for – especially considering the severity of SK's deficits.

More detailed evaluation of SK's recall of graphemic representations on a letter-by-letter basis also revealed that he had retained knowledge of double letters within words, and that this knowledge improved following therapy. Whilst the number of double letters within the word sets was too small to provide statistical evidence for this finding, anecdotally SK's ability to identify the double letters within items supports Tainturier and Caramazza's (1996) hypothesis that double letters are encoded as a unit within a graphemic representation. This information may be protected following neurological damage even when accompanying letter identity information has been impaired.

The final question that this study aimed to investigate was the potential for improvement following spelling therapy even when the programme of treatment was shorter and less involved than those illustrated by Beeson and colleagues (1999, 2000, 2002). As the above findings prove, the therapy conducted with SK was successful for the items treated and also in order to identify more detailed information about the nature of his graphemic representations. The success of the therapy programme implied that the adaptations which had been made still allowed SK's unimpeded access to treatment, despite his complete agraphia and emotional difficulties, and proved that spelling therapy can be a useful and effective approach to aphasia therapy, even given the time constraints most modern therapists experience.

Due to the severity of SK's difficulties, it was not possible to use his improvement to draw any strong conclusions with regard to the more specific nature of the breakdown in his spelling framework – he remained globally dysgraphic following therapy. However, his carer reported that during the therapy programme SK would frequently write the first letter of a word to try and convey a message to her. This technique was also witnessed by the therapist along with SK becoming more likely to try writing when prompted to do so in conversation. These slight changes in SK's communication style indicate that spelling therapy could be developed in a more functional way, as described by Beeson (1999), in order to have an even greater impact on SK's life.

It was unfeasible to test SK's maintenance of his improvement due to the time limitations of the study, therefore unfortunately whilst the gains he made were significant there is no proof that therapy had a lasting effect. This is often a difficulty with various types of aphasia therapy – including spelling treatment – in that without ongoing intervention gains are not always sustained (Ellis & Young 1988). With hindsight this should have been planned into the therapy study design, along with multiple baseline tests in order to isolate SK's improvements as solely due to therapy and thereby improve the validity of the study.

Finally, SK's status as a polyglot aphasia subject suggests that investigation of his ability to spell in Serbian following his stroke, in comparison to his English orthographic abilities could provide a reason to evaluate his performance according to a different cognitive neuropsychological framework (Luelsdorff & Eyland 1991). Since there is evidence that first languages are encoded in a separate area of the brain to those which are learnt subsequently (Hamers and Blanc 2000), this information may lead to the conclusion that SK would be able to

achieve greater success with spelling therapy in Serbian than in English. There is very little literature surrounding the spelling impairments of polyglot aphasics and how these differ between languages, but SK would provide an excellent subject for further research in this area.

Overall this case study has provided an informative extension to the literature surrounding dysgraphia treatments, and the success of the therapy has shown that spelling therapy can be effective both for treated items, and that in-depth analysis of the pattern of graphemic representations is a worthwhile undertaking since it can show surprising results, including generalisation to untreated items.

Word Count: 8516

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APPENDICES

Appendix 1: List of Therapy vs. Control Sets

Therapy Set	Control Set
COFFEE	LIGHT
HOT	COLD
SOCKS	BOOK
WHISKEY	YESTERDAY
DAUGHTER	TISSUES
HOLIDAY	BRANDY
HAPPY	SAD
EAT	DRINK
SLEEP	BED
FRIEND	SISTER
CHAIR	PHOTO
PILLOW	HUNGRY
TABLET	JACKET
IDEA	SERBIA
FOOD	TEA

Category	Therapy Set	Control Set
Noun	11	10/11
Verb	2	3
Adjective	2	1/2
No. Letters		
3	2	3
4	2	2
5	4	3
6	4	5
7	2	1
8	1	0
9	0	1
Total Letters	**78**	**80**

Appendix 2: Division of Therapy Set into 3 Sets

Set 1	Set 2	Set 3
COFFEE	HOT	SOCKS
EAT	SLEEP	HAPPY
PILLOW	FRIEND	TABLET
WHISKEY	DAUGHTER	HOLIDAY
CHAIR	IDEA	FOOD

Category	Set 1	Set 2	Set 3
Noun	4	3	4
Verb	1	1	0
Adjective	0	1	1
No. Letters			
3	1	1	0
4	0	1	1
5	1	1	2
6	2	1	1
7	1	0	1
8	0	1	0
9	0	0	0
Total Letters	**27**	**26**	**27**

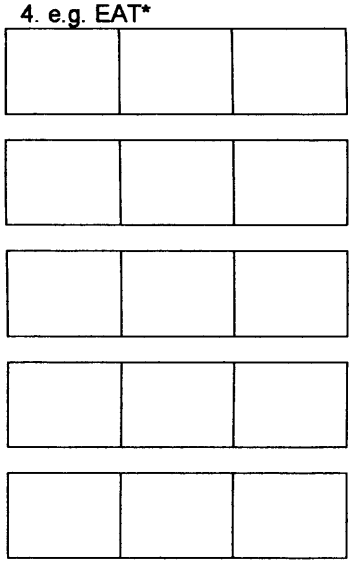
Appendix 3: SK's Response Sheet

1. e.g. . CHAIR*

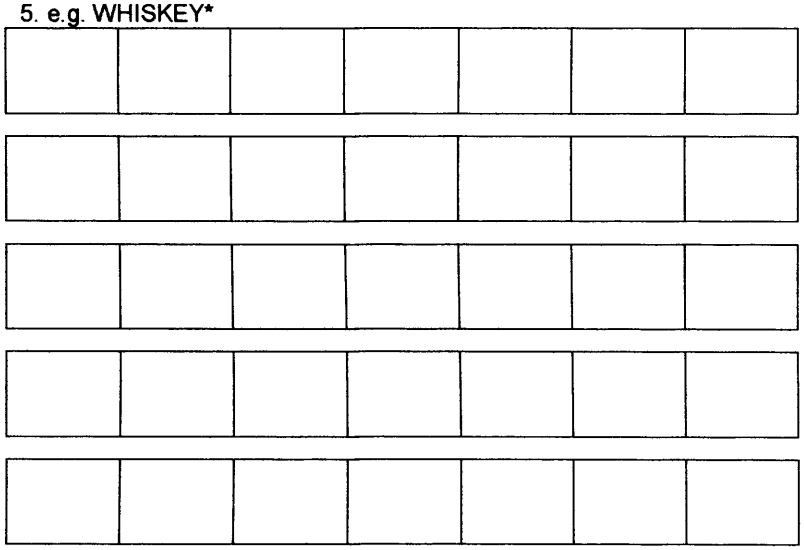
2. e.g. PILLOW*

3. e.g. COFFEE*

4. e.g. EAT*



5. e.g. WHISKEY*



* Word not included on SK's response sheets