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Title: Effects of therapy targeted at verb retrieval and the realisation of the predicate argument structure; A case study.

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Short title: Verb retrieval and PAS production

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Abstract

Background: Verb retrieval and sentence production difficulties are both common features of aphasia. Previous treatment studies have focused predominantly on verb retrieval and the mapping of semantic and syntactic structure. There have been more limited investigations of the production of the predicate argument structure (PAS).

Aims: This study aimed to evaluate the outcome of intensive therapy for a client with aphasia. NS had multiple and interacting difficulties that resulted in problems producing sentences. Therapy aimed to improve his sentence production by:- a) improving the retrieval of verbs b) increasing his awareness of the relationship between nouns and verbs and c) improving his production of one, two and three argument structures. The therapy thus targeted access to PAS information and PAS production as well as verb retrieval.

Methods: A period of intensive therapy, based around a set of 48 self-selected verbs, was preceded and followed by detailed assessment of NS's single word and sentence production and comprehension.

Outcomes and Results: Therapy resulted in a significant improvement in his retrieval of the verbs involved in treatment but no generalisation to other verbs. His production of sentences showed more widespread changes. He produced more nouns within sentences, omitted fewer obligatory arguments and produced a greater variety of argument structures in connected speech.

Conclusions: Therapy resulted in a greater awareness of the need for a verb within a sentence and a strategy for producing the argument structure frame around that verb. Improved sentence production was therefore seen although verb retrieval difficulties were still evident. The study replicates previous research that verb and sentence production difficulties can be treated effectively in people with aphasia. The effects of

therapy on sentence production in constrained tasks and narrative speech are discussed.

Introduction

Verb retrieval and sentence production difficulties are both common features of aphasia (see clients described by Berndt, Haendiges, Mitchum, & Sandson, 1997a; Berndt, Mitchum, Haendiges, & Sandson, 1997b; Miceli, Silveri, Villa, & Caramazza, 1984; Zingeser & Berndt, 1990). There is a strong consensus that the features co-occur and that clients who are poor at verbs generally produce fewer sentences and simpler sentences than people with aphasia who are better at retrieving verbs (Berndt et al., 1997b). This co-occurrence may suggest a unitary underlying impairment. However, the relationship between the two aspects is not straightforward and varies across clients. Clients have been reported with spared sentence production despite impaired verb retrieval (e.g. Client HW, Caramazza & Hillis, 1991). Conversely, client SK (Berndt, Haendiges, & Wozniak, 1997) had no verb retrieval deficit but severe sentence production difficulties.

Saffran, Schwartz and Marin (1980) put forward the 'lexical hypothesis' to explain sentence production difficulties. This proposes that the representation of the verb contains information that is necessary for sentence production. Therefore, as Marshall, Pring and Chiat (1998) suggest, verb deficits should always result in sentence difficulties although sentence processing problems may also be the consequence of other underlying impairments e.g. difficulties mapping between the semantic and syntactic structure of sentences. The lexical hypothesis also predicts that sentence production should improve when verb retrieval improves as a consequence of cueing or therapy. As client HW (Caramazza & Hillis, 1991) illustrates, however, verb retrieval deficits do not always result in sentence production impairments and the provision of verb cues and verb retrieval therapy have been shown to have varying effects on sentence production. As predicted by the lexical hypothesis, client EM

(Marshall et al., 1998) was able to produce more correct sentences when given a verb compared to when given a noun and following verb retrieval therapy, EM's sentence production improved. Similar gains in sentence production following verb retrieval therapy were also reported in Raymer and Ellsworth (2002). In contrast, client ML (Mitchum & Berndt, 1994) and client DL (Reichman-Novak & Rochon, 1997), despite improved verb retrieval following therapy, showed no changes in sentence production. Client ML and DL seemed to have additional sentence production difficulties not addressed in the verb retrieval therapy as following explicit structural training focusing on the production of syntactic structures, their sentence production improved.

Verb deficits, like noun deficits, can occur due to impairments at different levels of processing. Some verb deficits arise from failure to access the semantic representation (a semantic impairment) (e.g. Client MM, Marshall, Pring, & Chiat, 1993) and result in both comprehension and production difficulties. In some clients, (e.g. Client HW, Caramazza & Hillis, 1991) comprehension is intact but verb retrieval is impaired due to problems accessing the phonological output representation (a phonological impairment). A refined version of the lexical hypothesis outlined by Marshall et al. (1998) suggests that the effects on sentence production will differ depending on the level of the verb retrieval impairment.

There is a general consensus that semantic impairments have a more fundamental impact on sentence production than phonological impairments. Clients with phonological impairments are often able to produce the sentence frame even if they are unable to produce the verb. For example, GR (Fink, Martin, Schwartz, Saffran, & Myers, 1992) was able to produce a full sentence, with the nouns in the correct order, marking the missing verb with a gesture or a click. Client JS (Berndt et

al. 1997a/b) showed a lack of verbs due to a phonological impairment but was able to produce a sentence frame. When given the verb, the structure of his sentences remained unchanged; the authors suggest that this was because he already had access to the argument structure frame, so giving the verb gave no additional information. Semantic level impairments have been reported to result in a reliance on single phrases (particularly noun phrases) and limited use of sentence structure (Berndt et al. 1997b). This may arise from failure to retrieve the predicate argument structure (PAS) information that is part of the semantic representation of the verb (Levelt, 1989). The PAS determines the number of arguments that are required alongside the verb and the thematic roles that those arguments fulfil (Byng & Black, 1989). Failure to retrieve the semantic representation of the verb may thus result in a failure to activate the PAS, meaning that the nouns around the verb are not produced (Berndt et al. 1997b). In these clients, Berndt et al. suggest that giving the verb should provide access to the semantic representation, and therefore the PAS information, facilitating more accurate sentence production.

Once the semantic representation and the PAS information encoded within it has been retrieved, that information must still then be used to create the argument structure around the verb. Schwartz (1987) proposed that the creation of the PAS was a discrete process, depending on the conceptual specification of the event to be described as well as lexically specified information. There is some evidence from the detailed assessment of people with aphasia that selective deficits in PAS processing can be identified. Client JM (Webster, Franklin, & Howard, 2004) had no semantic or thematic role assignment difficulties but had problems with the creation of the PAS. When given a verb, she produced sentences with an inappropriate PAS due to the omission and addition of arguments. In grammaticality judgement tasks, she failed to

identify PAS anomalies and in an anagram task, she could not reject distracter arguments in order to select and produce an appropriate argument structure. Her difficulties were, however, reduced when she was given a picture; the picture in its depiction of the participants in the event seemed to give her clues to the argument structure.

Client AL (Webster & Whitworth, in press) was also able to understand and retrieve verbs but had difficulty creating the PAS and in assigning thematic roles. In sentence production, he produced simple one and two argument structures (with the two argument structures built mainly around the copula verb), a high percentage of single phrases and omitted arguments. Thompson, Lange, Schneider and Shapiro (1997) investigated the production of PAS by people with aphasia during conversational tasks. They showed that the people with aphasia produced verbs with simple argument structures, in terms of fewer arguments and a restriction in the variety of argument structure arrangements produced around each verb. These difficulties producing the argument structure may reflect specific problems in PAS processing but may also be a consequence of word retrieval or thematic role assignment difficulties.

There have been a number of therapy studies that have targeted verb retrieval and sentence production in people with aphasia. This section will review those therapy studies, concentrating on the underlying impairments and the patterns of improvement seen. Studies for verb retrieval have focused on the remediation of both semantic (e.g. Raymer & Ellsworth, 2002) and phonological impairments (e.g. Fink et al., 1992). These therapies have generally resulted in improved production of the treated verbs but no improvement in the production of untrained verbs. Marshall et al's (1998) study reported some generalisation to control verbs in the same semantic

categories as the treated verbs. As previously mentioned, patterns of generalisation to sentence production have been varied.

There have been a more limited number of therapy studies explicitly targeting PAS difficulties (e.g. Webster & Whitworth, in press) although some verb retrieval studies have also facilitated access to argument structure as part of the therapy process. For example, after the naming of the verb, Fink et al. (1992) in their 'direct verb training' asked the client to generate the agent and theme before producing a sentence to describe the target picture. Training resulted in improved production of the trained verbs but sentence production post-training was not examined. Similarly, Murray and Karcher (2000) cued argument production during the sentence phase of their written therapy. Following this therapy, their client HR improved on both sentence production and comprehension for treated verbs and sentence production in discourse tasks.

There have been a large number of therapy studies that have aimed to improve the mapping of thematic structure onto syntactic structure (see Mitchum, Greenwald, & Berndt, 2000 for a comprehensive review). The therapy studies are divided in two main types: i) verb centred therapies and ii) implicit feedback studies. The verb centred therapies (e.g. Jones, 1986) focus on verb meaning by asking the clients to identify the verb and noun phrases associated with particular thematic roles. The implicit feedback studies (e.g. Haendiges, Berndt, & Mitchum, 1996) aim to increase awareness about how different syntactic structures map onto meaning via sentence-picture verification tasks; these tasks do not have an explicit focus on the verb. Both types of studies have resulted in improved comprehension of the trained structures with limited generalisation to the comprehension of untrained sentence types. In addition, the verb centred therapy studies have resulted in improved sentence

production, with an increased use of verbs and verb argument structures in connected speech; this suggests some generalisation to untrained verbs. No similar gains in sentence production have been seen following the implicit studies. Although these mapping studies focus on the role that particular lexical items are fulfilling within the sentence and how those thematic roles are expressed syntactically, the verb centred therapies also highlight the importance of verbs and the arguments alongside them. The verb centred therapies may also thus address difficulties accessing PAS information.

This study presents a client with multiple problems in sentence production. The initial part of the paper presents the results of a variety of assessments investigating single word and sentence production and comprehension. The paper then describes a period of intensive therapy and its outcome. The therapy techniques aim to improve access to the verb and PAS information and the production of the PAS. The effects of therapy on sentence production in constrained tasks and narrative speech will be considered.

Method

i) Client

NS was a 49 year old gentleman when referred to the North East Aphasia Centre. He had had a CVA six years previously resulting in a mild right hemi-paresis and aphasia. Prior to his CVA, he worked for the civil service as a fisheries inspector. He left school at 15. NS had not received regular speech and language therapy for some time; he had approached the service to explore access to adult education. On referral, NS had adequate comprehension for everyday understanding. His speech was hesitant and was characterised by word-finding difficulties, sentence fragments and

abandoned sentences. He was motivated to attend the centre and it was thought that he would benefit from further direct therapy.

ii) Format

NS attended the centre for three days a week for a total period of twelve weeks, two weeks of assessment and ten weeks of therapy. After eight weeks, there was a four week break during which he completed similar activities independently and then therapy resumed. Each week, he received five, 45 minute individual therapy sessions and about ten hours of group therapy. This paper will describe the therapy he received during his individual therapy, although it is recognised that the therapy he received in the group may have had some impact on his progress. The overall aims of the group therapy were to reinforce the goals of individual therapy, promote successful communication, build confidence and provide an opportunity for peer support.

iii) Diagnosis

A variety of assessments investigating single word and sentence production and comprehension were carried out three months prior to the start of therapy.

Single Word Production and Comprehension

Single word production and comprehension tasks were used to assess access to semantic and phonological information for nouns and verbs. NS showed some mild difficulties in the comprehension of nouns and verbs. In the spoken and written word (noun) to picture matching sections of the Comprehensive Aphasia Test (Swinburn, Porter, & Howard, 2004), his performance was below the normal mean and he selected semantic distracters (spoken 14/15 compared to normal mean of 14.7, written 12/15 compared to normal mean of 14.9). On an unpublished synonym judgement task (described in Bird, Franklin, & Howard, 2000), he scored outside normal limits

for both nouns and verbs (51/60 nouns compared to normal mean of 57.5, 53/60 verbs compared to normal mean of 59.0). He correctly identified 47/48 verbs in a verb to picture matching task (for the verbs which were subsequently used in therapy).

The Verb and Noun Test (VAN, Webster & Bird, 2000) was used to compare single word noun and verb retrieval. NS was asked to watch the video clip and describe what was happening (verbs) or what it was (nouns) in one word. His retrieval of both nouns (43/54) and verbs (27/54) was impaired compared to normal control subjects (nouns, normal mean = 50.3, $t(16) = 6.533$, $p < 0.001$, verbs, normal mean = 52.6, $t(16) = 8.987$, $p < 0.001$). Verb retrieval was more impaired than noun retrieval ($\chi^2(1) = 9.14$, $p = 0.003$). His verb retrieval was slow and consisted of a variety of errors. In his verb production, he produced semantically related verbs e.g. 'jumping' for 'running', semantically related nouns e.g. 'tissue for 'sneezing' and 'TV' for 'watching' and sometimes he made a noun into a verb e.g. 'scissoring for 'cutting' and 'soldiering' for 'saluting'. Errors in noun retrieval were a mixture of semantic errors, circumlocutions and no responses. He was able to repeat words without difficulty.

Sentence Production and Comprehension

Sentence comprehension was assessed using the Test for Reception of Grammar (TROG, Bishop, 1983). NS scored 55/80 (7 blocks passed compared to the normal mean of 18.44 blocks), with an additional eight sentences correct following repetition. He made errors in the comprehension of reversible active, passive and embedded sentences, making mainly reverse role errors.

Sentence production was assessed using Thematic Roles in Production (TRIP, Whitworth, 1996) and a sentence generation task (described in Webster et al., 2004). TRIP contrasts the production of nouns in isolation and the production of one, two

and three argument structures from picture stimuli. The assessment is a delayed repetition task so all the words and sentences were modelled in blocks before NS was given each picture and asked to describe what was happening. Due to the high frequency of the nouns used in the TRIP, NS had no problems retrieving the words in isolation. In accordance with the test instructions, sentences were scored for noun retrieval, verb retrieval and thematic completeness. Figure 1 shows NS's performance on the sentences in TRIP. A significant difference was seen in his retrieval of nouns, verbs and thematic completeness across one, two and three argument structures (noun retrieval, χ^2 (2) = 28.16, p = < 0.001, verb retrieval, χ^2 (2) = 12.45, p = 0.002, thematic completeness, χ^2 (2) = 22.15, p = < 0.001). He produced a combination of different errors:-

a) Sentences abandoned at the point of the verb e.g. 'the man is giving the present to the girl' was produced as 'the man is'
b) The omission of the verb e.g. 'the mouse is chasing the dog' was produced as 'the mouse is…the dog'.
c) Substitution of the verb e.g. 'the girl is pulling the train' was produced as 'the girl is pushing the train'
d) The omission of an argument e.g. 'the girl is giving the book to the boy' was produced as 'the girl gives the book'
e) The production of reverse role errors for reversible sentences e.g. 'the boy is dragging the pig' was produced as 'the pig is dragging the boy'

(Figure 1 about here)

In the sentence generation task, NS was given a verb and asked to produce a sentence. No picture stimuli were given. Verbs were given in written form and read aloud by the therapist. The 74 verbs used in the task varied in terms of their PAS. For

over half the sentences (54.41%) NS produced had an inappropriate argument structure. He omitted arguments in both pre-verb and post-verb positions e.g. ‘I instruct’, ‘losing the way’. He seemed unaware that the sentences he was producing were grammatically incorrect.

This combination of difficulties was also present in less constrained tasks of sentence production. A transcript of his production of the story of Cinderella can be seen in Appendix 1. The sample was obtained and transcribed and the narrative words were extracted using the guidelines in Saffran, Berndt and Schwartz (1989). At this stage, NS required some prompts in order to continue with the task. The utterances were then analysed using the procedure described in Webster, Franklin and Howard (2001). A mean thematic complexity score was calculated; this was a weighted mean which reflected the range and complexity of argument structures and whether non-arguments (additional information about time, manner or place) were produced. NS’s utterances were less complex than normal subjects; his mean thematic complexity of 2.27 was more than two standard deviations from the normal mean of 3.15 (2 sd below mean = 2.71). He produced a high percentage (36.36%) of single phrases with an undetermined argument structure e.g. ‘the stepmother’ compared to normal speakers (mean of 2.54%, 2 sd above the mean = 8.45%). His remaining utterances were two argument structures based predominantly (85% of sentences) around the copula verb e.g. ‘it’s the rags again’. He produced no three argument structures or complex utterances with thematic embedding.

Interpretation

NS’s impaired sentence production seemed to be a consequence of multiple difficulties.

a) Difficulty accessing the semantic representations of both nouns and verbs

NS scored below normal limits in noun and verb comprehension and production tasks suggesting a mild semantic impairment. Semantic errors were prevalent in single word naming. His increased difficulty with verb retrieval may reflect the lower imageability of verbs (Bird et al., 2000). His word retrieval was, however, more impaired than his comprehension; this may reflect the way in which comprehension was assessed and in particular the relative ease of the verb picture matching task or may indicate that NS had additional difficulties accessing the phonological representation of the verb. In sentence production, his failure to retrieve a verb resulted in abandoned sentences and an over-reliance on single phrases.

b) Difficulty specifying the predicate argument structure.

NS's impaired sentence construction was not just a consequence of his semantic difficulties as even when given the verb, he found it difficult to produce the PAS. He made errors in the production of two and three argument structures in both the TRIP and sentence generation tasks, omitting arguments. Within the narrative, these difficulties may account for his heavy reliance on the copula verb and the production of single phrases with an undetermined thematic structure.

c) Difficulty assigning lexical items to thematic roles within the PAS

Reverse role errors in sentence comprehension and production would suggest impaired thematic role assignment and/or mapping. Impaired thematic role assignment may also account for the omission of arguments in complex argument structures (Schwartz, Fink, & Saffran, 1995).

At the start of therapy (three months later), a more limited set of assessments was carried out. There was no change in his sentence comprehension on the TROG (score 51/80 compared to 55/80 three months previously) and the mean complexity of his utterances within narrative production remained unchanged (2.27 three months

pre-therapy and 2.24 immediately prior to therapy). This would suggest that performance was stable prior to therapy; this would be expected considering that NS was over six years post-onset.

iv) Therapy

Following from this interpretation of NS's assessment results, therapy concentrated on three major aims:-

1. To improve verb retrieval
2. To improve NS's awareness of the relationship between the verb and nouns within the sentence
3. To improve the production of one, two and three argument structures.

The therapy thus aimed to improve sentence production by enabling NS to retrieve verbs, strengthening his knowledge of PAS information and then enable the creation of the argument structure. All of the therapy activities used the same 48 verbs. These were verbs chosen by NS and were from functional categories relevant to his hobbies and everyday life e.g. DIY, gardening and food. A list of the verbs and their syntactic classifications can be found in Appendix 2. The syntactic classifications taken from the CELEX database (Baayen, Piepenbrock, & Gulikers, 1995) were used as a guide to the argument structures associated with the verb. NS had demonstrated that he understood these verbs (score of 47/48 in a verb picture matching task) but was only able to retrieve 21/48 of them prior to therapy.

Three main therapy tasks were used.

1. Verb Retrieval

NS was asked to look at a picture of the verb and name the action following a semantic task which had required him to access the meaning of the word (as in Marshall et al., 1998). A variety of semantic tasks were used including spoken and

written word to picture matching, spoken and written word to picture verification, odd one out and synonym judgement. If NS was unable to name the verb following the semantic task, the word was presented to him for repetition. Verb retrieval was treated for the first 6 weeks of therapy and he did some sentence completion tasks (with the same items) during the four week break.

2. Verb and Noun Association

Throughout therapy, NS was presented with written worksheets for the same 48 verbs in which he was asked to identify noun and verb associations in terms of the thematic role that the nouns could play within the sentence.

For example:

Read the action and decide which two of the people would normally do the action.

Digging	farmer	doctor	gardener	ballerina

Read the action and decide which two of the objects the action can be done to:-

Digging	soil	tarmac	carpet	hole

In each case if NS selected a wrong word, the target words and error response were contrasted focusing on the meaning of the verb. As therapy progressed, the targets and distracters used had a greater semantic relatedness and at the final stage of therapy, the distracters used could fulfil another role within the sentence.

For example:

Read the action and decide which two of the objects the action can be done to:-

Digging	garden	spade	trowel	soil

If NS selected a wrong word, the target and error responses were contrasted focusing on the thematic role that the word was fulfilling.

3. Sentence Generation

NS was introduced to a framework that encouraged him to think about the necessary components and additional parts of a sentence. He was asked to generate words that could fulfil particular thematic roles (or conveyed particular information) and then use the words to generate some appropriate sentences. An example of the words generated for the verb 'wash' can be seen in figure 2. As each sentence was generated, it was written down and NS discussed with the therapist whether there were any missing components and which parts of the sentence were optional or obligatory. This task was adapted from Fink et al. (1992) but it had some fundamental differences; no picture was used and NS was asked to think about all of the PAS arrangements associated with the verb as well as non-arguments (optional information about manner and place) that could also be part of the sentence. As therapy progressed, NS was encouraged to think of more words and to think broadly about the diverse meanings of the verb. (Figure 2 about here)

Results

During the verb retrieval therapy, a significant change was seen in NS's retrieval of the 48 verbs between weeks one, three and six of therapy ($f(2) = 7.81$, $p = < 0.001$). This can be seen in figure 3. NS was then reassessed on the other assessments at the end of the block of therapy. Unfortunately, naming of the treated verbs was not reassessed at this time. At the 12 week reassessment, no significant improvement was seen in NS's retrieval of verbs on the Verb and Noun Test (VAN) (27/54 pre-therapy, 28/54 post-therapy). For the verbs that were part of both the treatment set and in the VAN, NS scored 6/9 pre-therapy and 8/9 post-therapy. This suggests there was no overall improvement (generalisation) in verb retrieval. He continued to produce semantically related errors. (Figure 3 about here)

Figure 4 contrasts NS's production of one, two and three arguments structures on the TRIP pre- and post-therapy. Post-therapy, NS's performance on one argument structures was at ceiling whilst performance on two and three argument structures remained outside the normal range (95-100% correct). The significant difference in noun retrieval, verb retrieval and thematic completeness across one, two and three argument structures persisted (noun retrieval, χ^2 (2) = 9.58, p = 0.008, verb retrieval, χ^2 (2) = 25.79, p = <0.001, thematic completeness, χ^2 (2) = 26.79, p = < 0.001). Scores for verb retrieval and thematic completeness for two and three argument structures remained low. This scoring of sentences (as according to the test instructions) failed to capture the changes that were seen in NS's performance on this assessment. Figure 5 shows more information about the verbs produced during the TRIP assessment pre- and post-therapy. Post-therapy, a significant change was seen in the production of correct verbs and incorrect verbs and the omission of verbs (z (1) = 2.66, p = 0.008). Although the number of correct verbs did not change, NS was retrieving more verbs. These verbs were semantically related and often contextually plausible alternatives to the target e.g. 'emptying' for 'carrying' and 'nudging' for 'pushing'; these were not verbs that had been treated during therapy. The retrieval of a verb enabled the post-verb nouns to be produced. For example, for the target sentence 'the boy's giving the flower to the woman', NS produced 'the boy picks the flower for the woman' and for 'the woman's showing the door to the dog' he produced 'the woman is opening the door for the dog'. So although the scores on TRIP for verb retrieval and thus thematic completeness remained low, NS had produced more verbs and the argument structure around those verbs was generally appropriate. (Figure 4 and 5 about here)

In the sentence generation task when given a verb and asked to produce a sentence, there was a decrease in the percentage of structures that had an

inappropriate argument structure (from 54.41% pre-therapy to 11.76% post-therapy). Post-therapy, NS was omitting less arguments. Some examples of the sentences he produced were:-

blame ‘the man blames it on the dog’

teach ‘the man teaches the woman how to write’

instruct ‘the man instructs his wife to do some work’

Sentence comprehension on the TROG remained unchanged (55/80 pre-therapy compared to 58/80 post-therapy). Performance on other assessments unrelated to therapy also remained unchanged e.g. written naming 16/52, three months prior to therapy and 11/52 post-therapy (items taken from test described in Nickels & Howard, 1994).

The transcript of NS’s post-therapy production of the story of Cinderella can be seen in Appendix 3. At this stage, he required no prompting in order to produce the story, although this may just reflect an increased familiarity with the task. Post-therapy, NS’s mean thematic complexity score increased from 2.27 to 2.53; this remained outside two standard deviations of the normal mean. Post-therapy, he produced less single phrases (21% compared to 36.36%) but this was still a high percentage compared to normal speakers (normal mean = 2.54%). Post-therapy, the most noticeable change in his narrative speech was that his two argument structures were built around more lexical verbs e.g. ‘the king went dancing’ ‘the clock strike er … 12’oclock’. The proportion of sentences built around a lexical verb increased from 15% pre-therapy to 43% post-therapy. Many sentences were, however, still built around the copula verb e.g. ‘there was er cinderella . with erm . the ugly sisters’.

Discussion

This paper has described assessment and therapy for a client with aphasia. Detailed assessment on constrained tasks of sentence production was necessary to determine the nature of NS's verb and sentence production difficulties. This assessment suggested that his difficulties did not have a single origin. Firstly, he had a mild semantic impairment resulting in word retrieval difficulties for both nouns and verbs. Secondly, he found it difficult to produce the predicate argument structure (PAS) around a verb and thirdly, he had difficulty assigning words to thematic roles within the PAS. Each of these areas will now be considered in light of the outcome of therapy.

With regard to the first area of difficulty, it was suggested that NS had a semantic impairment resulting in word retrieval difficulties. NS made some errors in the word (noun) to picture matching and noun and verb synonym tasks but made no errors in the comprehension of the treated verbs. Berndt et al. (1997a) suggest that 'it is not clear that failure to demonstrate parallel effects in comprehension and production strongly constrains potential sources of the production impairment' (p98). NS's verb semantic impairment may not be of sufficient magnitude to result in difficulties in picture selection but may still result in difficulties retrieving the word. A mild semantic impairment was evident in the more difficult synonym judgement task. A semantic level of impairment was also suggested by the observation during therapy that as more detailed semantic discrimination was required in the verb and noun association tasks, NS made more errors. NS's error patterns in production support a semantic level of impairment; he produced semantically related errors for both nouns and verbs and produced semantically related nouns instead of verbs. Due to the difficulty of directly comparing comprehension and production tasks for the

treated verbs, it is impossible to rule out that NS may have had additional difficulties accessing the phonological representation of the verbs from the semantic information. There was, however, no effect of frequency and he was able to repeat the words, suggesting that a phonological impairment was unlikely to be responsible for his verb retrieval deficit.

Secondly, it is proposed that NS had difficulty specifying the PAS. NS's failure to access the semantic representation of the verb could account for his difficulties retrieving nouns within the context of a sentence. However, even when given the verb in auditory and written form in the sentence generation task, he still produced inappropriate argument structures. Similarly, noun retrieval difficulties might also result in the omission of obligatory arguments in the sentence generation task but NS also omitted arguments in TRIP when he was able to retrieve the nouns in isolation. In the production of the narrative, he produced a lot of single phrases and simple one and two argument structures (with the two argument structures based around the copula verb). This pattern of impairment is consistent with the difficulties seen in other clients with argument structure difficulties such as AL (Webster & Whitworth, in press). Thirdly, NS presented with impaired thematic role assignment. This is evident in his problems with reversible sentences in comprehension and production and may account for the omission of arguments in complex argument structures.

NS had a combination of sentence production difficulties for which therapy could be targeted. Therapy aimed to reduce his sentence production difficulties by improving access to verbs and the specification of the argument structure. This was achieved by firstly facilitating access to the semantic representation of the verb, by secondly encouraging NS to think about PAS information by identifying the

relationship between verbs and nouns and by thirdly, practising the production of one, two and three argument structures. Thematic role assignment was not explicitly targeted in therapy although the production of the sentences obviously required this.

Prior to therapy, NS's performance on a variety of assessment measures was stable. He was a long time post-onset and no significant changes were seen between assessments carried out three months before and immediately prior to therapy. Following therapy, significant changes were seen in NS's sentence production but other aspects of performance remained unchanged. This would suggest that the changes seen in sentence production were a direct consequence of the therapy received. This study thus provides additional evidence that verb retrieval and sentence therapy can result in significant improvement in clients with aphasia.

Following therapy, there was a significant change in NS's ability to retrieve the treated verbs. No generalisation was, however, seen in his ability to retrieve untreated verbs in a single word naming task. This replicates the findings of other verb therapy studies e.g. Fink et al., (1992), Raymer and Ellsworth, (2002). More widespread gains were seen in his sentence production. In the TRIP assessment and the sentence generation task, he was able to specify the PAS, producing more nouns within the context of two and three argument structures and omitting less arguments. He used verbs that were not included in the therapy set and was able to use those verbs in the context of an appropriate argument structure. In narrative speech, he produced less single phrases and a greater variety of argument structures.

Therapy seemed to have two distinct results. Firstly, NS had improved access to and retrieval of a set of personally useful verbs. Secondly, therapy resulted in a more general improvement in the marking of a verb in sentences and in the specification of verb argument structure. Therapy seemed to encourage NS to think

about the action and what information was needed alongside the verb. This enabled him to produce more complete sentences, more complex sentences and a greater variety of argument structures following therapy. The final part of the discussion will consider how this improvement may have taken place and what the outcome of therapy suggests about the processes involved in sentence production.

NS's improved verb retrieval (treated items only) could have been due to a strengthening of the semantic representations. Alternatively, if NS's initial difficulty reflected a problem accessing the word forms, therapy may have strengthened the connection between semantic representations and phonology. In either case, treatment was verb specific as no improvement was seen in the retrieval of other verbs in the single word naming test. What this improvement in accessing verb specific information cannot explain is NS's increased use of verbs in TRIP and in the production of the narrative. It is, however, unlikely that the production of verbs in these contexts reflects generalisation to untreated verbs that was not seen in the simpler naming task. NS produced more verbs but they were often not the most semantically appropriate. It seems likely that the improved marking of verbs within sentences reflects a renewed awareness of the role of verbs which then facilitated the production of the PAS.

The reduction in the omission of verb arguments and the production of more complex argument structures post-therapy is unlikely to be due to improved thematic role assignment/mapping as no change was seen in reversible sentence comprehension. NS also continued to make some reverse role errors in TRIP. It also seems unlikely that sentence production improved due to the availability of verb specific argument structure information. If therapy had strengthened access to lexically specified PAS information, improvement would have been restricted to the

treated verbs. Instead therapy seemed to give NS a general strategy that enabled him to specify the arguments around verbs he could produce. The distinct differences seen in the verb specific effect of the word retrieval therapy and the generalised benefits of the PAS therapy provide additional support that NS did have multiple difficulties in sentence production. Pre-therapy, it is unlikely that his problems producing argument structure reflected only a difficulty accessing the semantic representation of the verbs (and any PAS information encoded within that representation). The fact that the creation of the PAS can be targeted via a general strategy provides additional evidence that it is a discrete process in sentence production (as suggested by Schwartz, 1987, Webster et al., 2004).

The outcome of therapy in terms of the effect on sentence production in constrained tasks and in narrative speech resembles that of the verb-centred mapping therapies. Mitchum et al., (2000) suggest that the increased use of verbs and verb arguments following mapping therapy, although a positive result of treatment may not be indicative of improved thematic mapping; clients in the mapping studies rarely show improvement in the production of non-canonical structures e.g. passive sentences that require complex mapping. In many ways, the focus of the verb-centred mapping therapies and the therapy described in this paper are very similar. Both highlight the importance of the verb and the arguments/thematic roles associated with them. It may be, therefore, that as part of the mapping therapy, treatment facilitates clients' creation of the PAS with the verb (or some 'marking' of the verb) pivotal and it is this that accounts for the benefits in sentence production seen post-therapy.

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Appendix 1: Transcript of Cinderella sample (three months prior to therapy)

NS yeah . um well first of all erm … first of all er it's erm …. the little daughter … and erm … the erm er ah oh god …. called cinderella … erm ….. and it's er … it's it's racing through me mind erm ….. it's it's a little daughter called cinderella erm

T and who did she live with?

NS … er the erm the stepmother . and it's er … the um .. the other the other daughters two of them two of them and it's er all cleaned and polished and er all sorts of things like that . erm and then the er the ….. er what's it called .. the erm …. the er …. the fairy godmother fairy godmother and it's er becoming a lady … erm .. and it's wed and that's that

T how did she meet him? where did she meet him?

NS in a in a in a . function a function erm of great standing oh that's that's good isn't it erm the ball the ball yeah

T right . so did she meet him that night and fall in love or did something else happen?

NS erm no it's a … because it's erm …. because it's er see I'm 1 2 3 4 5 6 (continued to count silently on fingers) 12 o'clock and it's and it's er the rags again

T yeah

NS but I think it's the next day the erm er the prince was married to erm cinderella

Key: T = Therapist .. = approximate length of pause in seconds

Appendix 2: List of verbs used in therapy and their syntactic classifications taken from the Celex Database (Baayen et al., 1995)

	Verb	**Syntactic Classifications**
1	To bite	T TC I
2	To chop	T TC I D
3	To cook	T I L
4	To copy	T I
5	To cut	T TC I D L
6	To cycle	I
7	To dig	T I
8	To draw	T TC I L
9	To dress	T TC I L
10	To drink	T TC I
11	To drive	T TC I L
12	To dry	T I
13	To eat	T TC I L
14	To file	T TC L
15	To hammer	T I
16	To hang	T I L
17	To hit	T TC
18	To hug	T TC
19	To kiss	T TC I D
20	To knit	T I D L
21	To lace	T TC

22	To lick	T I
23	To measure	T I L
24	To mow	T I
25	To open	T I
26	To order	T TC I D
27	To paint	T TC I
28	To paste	T TC
29	To phone	T I D
30	To pour	T TC I D L
31	To print	T I L
32	To rake	T I L
33	To read	T I D L
34	To ride	T I L
35	To saw	T I L
36	To screw	T TC I L
37	To serve	T TC I D
38	To sew	T I L
39	To shave	T I L
40	To shower	I D
41	To slice	T TC I L
42	To sow	T I
43	To spit	T I
44	To tickle	T I
45	To travel	T I L

46	To type	T I
47	To wash	T TC I L
48	To write	T I D

Key

Transitive (T) Verbs which take a direct object e.g. the policeman arrested the thief. Sentences with transitive verbs are two argument structures. The most common thematic structure associated with these verbs is:- Agent + Verb + Patient. Other structures include:- Experiencer + Verb + Patient and Possessor + Verb + Patient.

Transitive plus complementation (TC) Verbs which take a direct object and an object complement. Object complements can be a NP, AP, PP or clause e.g. they threw him into jail. Sentence with transitive plus complementation verbs are three argument structures. The most common thematic structures associated with these verbs are:- Agent + Verb + Patient + Instrument and Agent + Verb + Patient + Locative.

Intransitive (I) Verbs which occur without a direct object e.g. the man is sneezing. Sentences with intransitive verbs are one argument structures. The most common thematic structures associated with these verbs are:- Agent + Verb and Experiencer + Verb

Ditransitive (D) Verbs which take two objects, one direct object and one indirect object e.g. he wrote Jane a letter. Sentences with ditransitive verbs are three argument structures. The most common thematic structure associated with these verbs is:- Agent + Verb + Patient + Benefactive.

Linking verb (L) Verbs which occur with subject complements. Subject complements can be a NP, AP, PP or clause. e.g. she stood tall, Max ran for parliament. Sentences with linking verbs are two argument structures. The most common thematic structure

associated with these verbs are:- Patient + Verb + Attributive and Patient + Verb + Locative.

Appendix 3: Transcript of Post-Therapy Cinderella Sample

NS once upon a time there was er cinderella . with erm . the ugly sisters and erm .. oh …. erm .. it's a poor little cinderella erm .. erm …. had had no shoes or socks and was erm /ɹægədi/ and .. with er erm no erm something or other erm er .. not sure erm like a dress but all in rags right erm and then . the /vɛɹɪ /the /vɛɹɪ/ the fairy godmother erm called and you you shall go to the ball er and er and it's er whoosh whoosh (gestures waving the wand) and erm and it's erm the slippers and the the dress and the tiara and all the rest of it and it's fine so erm oh and er the erm the erm the coach and horses and erm er the rest of it anyway the king went er dancing and erm …. and dancing then all of a sudden erm the clock strike er 1 2 3 4 5 6 7 8 9 10 11 12 o'clock and erm and it's er it's in rags again but is happy happily ever after because the erm shoe with the er diamonds or something erm .. and it's happily ever after

Key: .. = approximate length of pause in seconds

Figure 1

Performance on Thematic Roles in Production (TRIP)

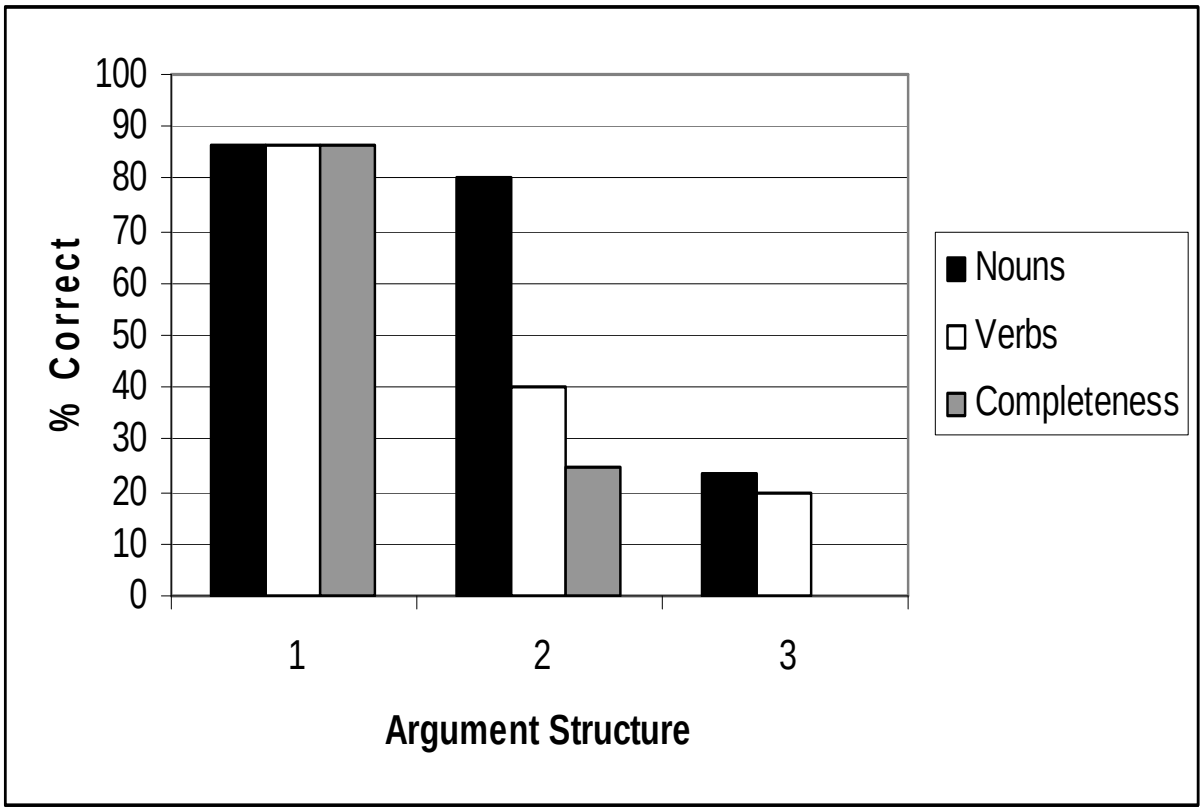

Figure 2

Example of sentence generation therapy task

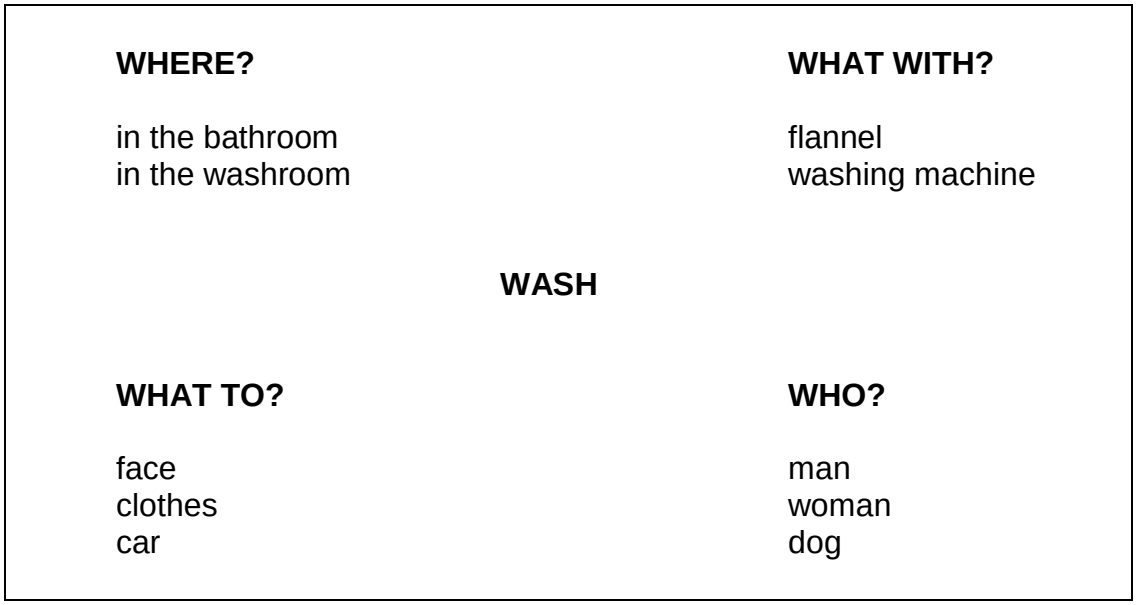

Figure 3
Retrieval of verbs during therapy

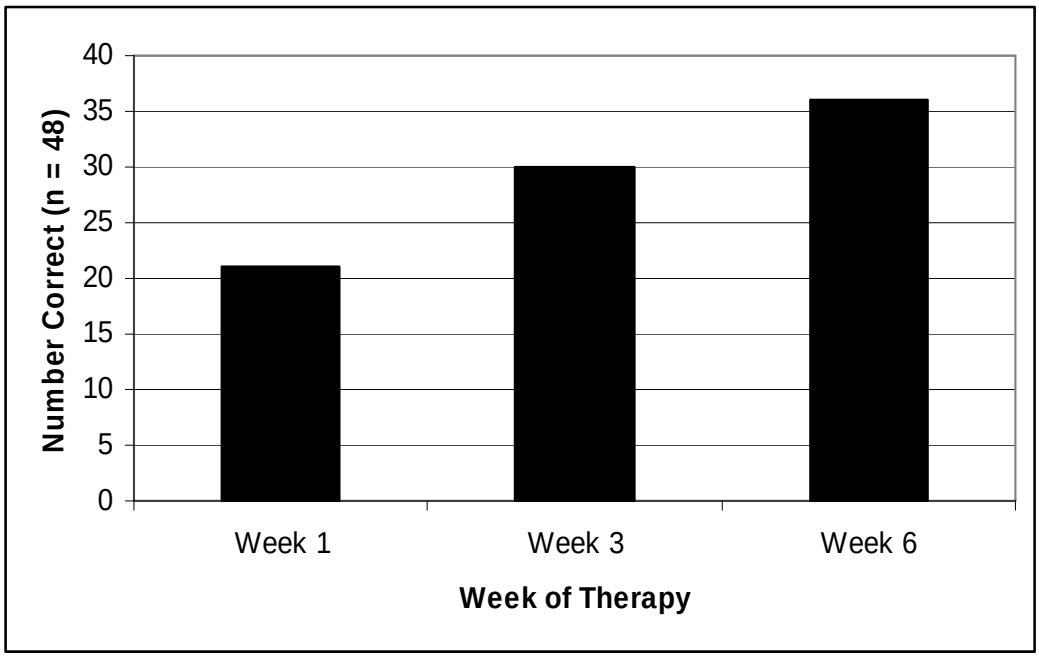

Figure 4

Comparison of performance on Thematic Roles in Production (TRIP) pre- and post-therapy

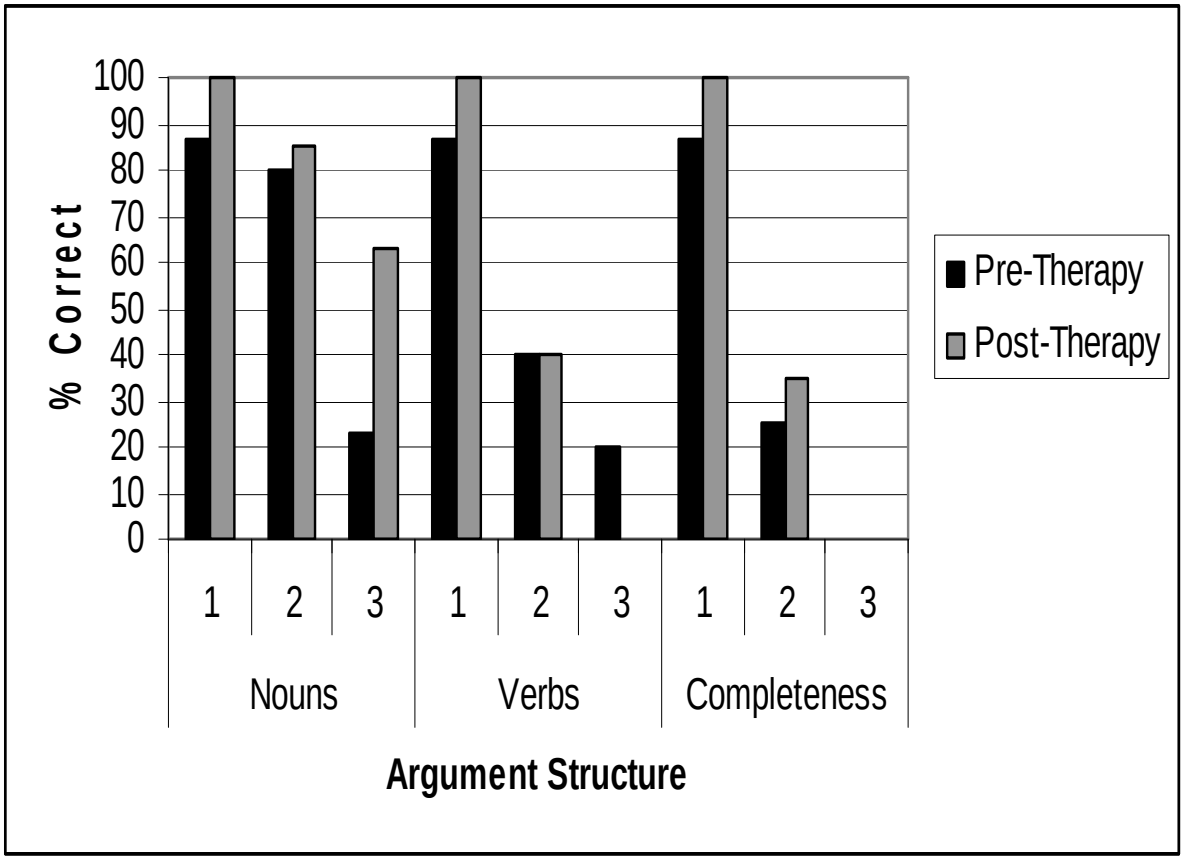

Figure 5
Retrieval of verbs in Thematic Roles in Production (TRIP) pre- and post-therapy