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TITLE: Syntactic versus lexical therapy for anomia in acquired aphasia: Differential effects on narrative and conversation

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Abstract

Background

Previous studies of therapy for acquired anomia have treated nouns in isolation. The effect on nouns in connected speech remains unclear. In our recent study we used a novel *noun syntax therapy* (Herbert, R., Webster, D., & Dyson, L., 2012, Effects of syntactic cueing therapy on picture naming and connected speech in acquired aphasia. *Neuropsychological Rehabilitation*, 22, 609-633) and found an increase in the number of determiner plus noun constructions in narrative after therapy.

Aims

Two aims arose from the previous study: to identify the critical ingredient in the noun syntax therapy, specifically whether this is lexical production, or the syntactic context; to extend the analysis of the effects beyond narrative into conversation.

Methods and procedures

We compared the effects of lexical therapy with those of noun syntax therapy in one individual with aphasia, in a sequential intervention design. We analysed the effects on conversation and on narrative.

Outcomes and Results

There was improved picture naming of treated words after both therapies. Lexical therapy had no impact on narrative and conversation, whereas noun syntax therapy led to more noun production, primarily in the context of determiner plus noun combinations.

Conclusions and implications

The results support the claim that greater impact on narrative and conversation can be achieved for some people with aphasia, by treating nouns in syntactic contexts.

What this paper adds

Research into anomia therapy suggests that purely lexical approaches, treating words in isolation, are not guaranteed to impact on narrative or conversation. We describe here a therapy which provides one means of bridging that gap, by treating nouns in determiner plus noun phrases. In this single case study we found an impact on narrative and conversation from the noun syntax therapy but not from the lexical therapy. We provide prognostic indicators relating to selection of this therapy for other speakers with aphasia.

Declaration of interest:
The intervention described in this article is based on a similar intervention described in Herbert et al. (2012), instantiated in a software program. A version of the program (STAR: Sheffield Therapy for Anomia Rehabilitation) is undergoing testing prior to commercial licensing.

INTRODUCTION

Most people with aphasia present with some degree of anomia (e.g. Nickels, 1997). This affects production of words, both in everyday conversation, and in test situations. The impact is significant in terms of reduction in the quality of communication life. Theories of spoken word production have been applied to this deficit in order to refine diagnosis, and inform intervention (Lesser, 1989). Models incorporating semantic and phonological representations have dominated (e.g. Caramazza, 1997). Assessment of these two levels is routine in research and clinical work, and related therapeutic methods have emerged.

Evidence exists regarding the effectiveness of semantic approaches (e.g. Boyle & Coelho, 1995; Howard, Patterson, Franklin et al., 1985) and phonological approaches (e.g. Herbert, Best, Hickin et al., 2001; Fisher, Wilshire, & Ponsford, 2009; Hickin, Best, Herbert, et al., 2002; Hickin, Herbert, Best, et al., 2006; Miceli, Amitrano, Capasso, & Caramazza, 1986). These therapies target nouns in isolation, hereafter referred to as 'lexical therapy'. The research has shown shown positive outcomes on picture naming, primarily for items treated in therapy (see Wisenburn & Mahoney, 2009).

The findings above are encouraging, but the extent to which lexical therapy impacts on everyday communication remains unclear. Studies have analysed narrative, discourse, or video-retelling (e.g. Conroy, Sage & Lambon Ralph, 2009). A few studies have attempted to measure conversation. Herbert, Hickin, Howard et al. (2008) proposed a method for assessing lexical retrieval in conversation which Best, Grassly, Greenwood et al. (2011) used to assess lexical retrieval in 13 people with aphasia. They report improved lexical retrieval in conversation in around half of the participants. This suggests that lexical therapy may in some cases engender generalised improvement to noun retrieval, whilst in others there is little effect. In the interests of all people with aphasia, whose main concern is their ability to converse daily with other people, this lack of strong evidence means that alternative approaches need to be considered.

The mechanism underlying lexical therapy has been explained within the context of single word production theories such as that described by Caramazza (1997). Miceli et al., (1996) refer to this theory to explain their finding of item-specific effects of phonological therapy. They hypothesised that therapy strengthens the links between word-specific semantic and phonological representations, thus only those words directly treated in therapy benefit. Howard, Hickin, Redmond et al. (2006: 960) proposed that therapy operates by simultaneously raising the resting level of activation of a target word's nodes at an intermediate lemma level (see below) and the phonological level, which may also strengthen the mapping between levels. This increased efficiency of the system results in easier retrieval of words practised in therapy, but no change to untreated words.

Of interest here is a second group of theories, which incorporate an independent lexical syntactic lemma level in their architecture (e.g. Dell et al., 1997; Levelt et al., 1999). Lexical syntax is integrated in the processing system, accessed from lexical semantics, and providing access to phonological output. The word-specific syntactic information accessed here is separate from sentence syntax, but links closely to that knowledge. Lexical syntactic knowledge includes word class information, and, for nouns, grammatical gender, plural form information, and mass and count status. Access to lexical syntax within the lexicon informs the construction of noun phrases, and the links to sentence syntax then allow sentences to be constructed. It is feasible that this level of representation may be impaired in aphasia, and, in

such cases, a targeted therapy should address that impairment. In addition, in order for people with aphasia to produce structures beyond single words, therapy which facilitates both single noun production and related phrase-level lexical syntactic information, might be beneficial. This therapy might enable the production of full noun phrases, and these can then combine with other phrase structures in connected speech.

Evidence exists however which indicates that lexical syntax is only likely to be activated when explicitly required, such as when marking gender (Levelt et al, 1999; Schriefers, 1993). When explicit surface marking of syntax is not required, for example in picture naming of objects, lexical syntactic information may not be automatically activated. The tasks used in lexical therapies do not require explicit marking of syntax, which suggests that these interventions will not automatically activate lexical syntactic information.

To address this, Herbert, Webster and Dyson (2012) developed a novel form of intervention, based upon theories incorporating lexical syntax. They described an original intervention for word-finding deficits, termed *noun syntax therapy*, which they trialled with six participants with aphasia. The therapy focused on production of nouns in determiner plus noun structures. Picture naming improved after the intervention for five of the six participants, and positive effects were also found on determiner plus noun production in narrative for five participants.

The authors explained the effects with reference to the notion of scaffolding (Linebarger, McCall & Berndt, 2004), provided by the syntactic frame. Provision of the frame lessens the demand on resources, thereby easing production of connected speech. As a result, speakers can concentrate more resources on noun retrieval itself. The noun syntax intervention targets the determiner plus noun phrase, so the linguistic structure of determiner plus noun may be easier to access after therapy, and this supports insertion of nouns into the noun slot. This hypothesis has implications for generalisation of therapy effects beyond treated words to those not seen in therapy. From this it is feasible that therapy effects will generalise beyond the treated words. Thus nouns in general should be easier to produce, not just those seen in therapy sessions.

In our previous study this prediction was upheld for determiner plus noun production in connected speech, with five participants showing improvement. It was not upheld in terms of effects on untreated word sets however. We argued that this might be due to the test format, which asks participants to name untreated words using single nouns, and does not ask for related noun syntax production.

The issue of who might benefit from this type of intervention is critical. A deficit in noun syntax knowledge might be assumed to be specific to people with agrammatic aphasia, and thus the therapy might only be applicable to this group. In the previous study however we found impaired noun syntax in all six speakers, four of whom had fluent non-agrammatic output. Of these four speakers, three produced more determiner plus noun structures in their connected speech after therapy. The most impaired in determiner production were the two speakers with agrammatic aphasia, and one of these speakers increased their production of noun syntax structures, while the one with the most severe deficit did not. We are therefore open-minded about the relationship between general syntactic function, and the degree to which noun phrase information is available and is amenable to therapy.

The noun syntax therapy described in Herbert et al. (2012) contained two potentially active ingredients: a lexical component, involving production of the noun via repetition; and a

lexical syntactic component. Although there is no theoretical reason why this should be the case, it is possible that the lexical component contributed to the change in noun phrases in narrative. In the study described here we therefore isolated the effects of the two components, by comparing a purely lexical therapy with the noun syntax therapy.

We hypothesised that a lexical intervention targeting nouns in isolation would lead to gains in picture naming, no change to untreated noun sets, and no change to noun phrases in connected speech. In contrast, we predicted that the noun syntax intervention would lead to gains in picture naming, and to increased noun phrase complexity and noun production in connected speech. We remained equivocal on the likely effects of this therapy on untreated word sets, as the previous study had failed to find an effect.

We compared two interventions. A lexical therapy involving phonological cueing, derived from Hickin et al. (2002), was administered first. The lexical therapy was selected to act as a comparison for the noun syntax therapy. The latter was designed to increase awareness of the syntactic contexts in which nouns appear, i.e. after certain determiners, and hence increase production of determiner plus noun combinations.
For both therapies mass and count nouns were used. These differ in English in terms of their canonical syntactic structures, for example, singular count nouns combine frequently with ‘a’, whereas mass nouns combine frequently with ‘some’. We used these differences in the therapy in order to develop awareness of determiner plus noun phrases. We analysed the effects of both interventions on determiner and noun production in narrative and conversation.

METHODS

Participant

MH is female, aged 70 at the start of the study, right-handed, and a native speaker of British English. She had no known visual or hearing impairment and no other significant medical history. She was educated to age 14. At the time of the study she was living independently at home, supported by regular social contacts.

MH sustained a single ischaemic left hemisphere CVA six years prior to the study. She presented with non-fluent agrammatic aphasia, with a marked word-finding deficit, and a mild right-sided hemiparesis affecting the upper limb. She was aware of her language disability, and able to actively participate in assessment and therapy activities. She was recruited to the study via a voluntary services aphasia group. Ethical approval for the study was obtained from the University of Sheffield Research Ethics Committee and MH gave informed consent to participate in the research via aphasia-accessible information and consent form (Osborne, Hickin, Best et al., 1998). MH was the subject of an investigation into her noun syntax processing (Herbert & Best, 2010) but she did not take part in the study described in Herbert et al., (2012).

The results of language tests are presented in table 1. An extract from the Cinderella narrative before intervention, is shown in figure 1.

Table 1 here

Figure 1 here

MH has a significant word-finding deficit. She makes semantic errors in production, which she does not reject, including many category co-ordinate and associative errors. Mass nouns were significantly worse than count nouns, and her spoken production was cueable by noun syntax (Herbert & Best, 2010). Her semantic processing is mildly impaired. There was no evidence of a deficit in visual processing. MH has a possible mild impairment in output phonology, shown in repetition errors to low frequency/low imageability words, such as coffer repeated as 'coffee'.

Her reading aloud was impaired; she made semantic and visual errors, and could not read non-words, indicating deep dyslexia. Digit span was severely impaired. In spoken sentence comprehension MH made errors on reversible active sentences, sentences with embedded clauses, and those with moved arguments. The majority of errors involved selection of the reversible distracter.

MH's spoken production is non-fluent, interrupted by pauses and fillers, and contains some nouns, but few main verbs. She produced a range of noun phrases, including nouns in isolation, determiner *the* or *a* plus a noun, and numeral plus noun combinations. There were no explicit syntactic errors in noun phrase production, but there were omissions of determiners, and of nouns. She used the pronominal form "this one" frequently to replace the noun.

From the Cinderella narrative we computed MH's determiner index (Saffran, Berndt, & Schwartz, 1989) by taking the total noun phrases in the sample which required an obligatory determiner, and dividing into this figure the total produced correctly by MH. This gave a value of 0.56, indicating that MH has access to determiner plus noun constructions, but often omits obligatory determiners. In Herbert & Best (2010) we reported that MH was at chance on our noun syntax judgement task, which investigated explicit knowledge of noun syntax. Implicit knowledge was evident however, shown in her response to determiner cues (*a* and *some*), which facilitated her noun production, and the fact that her determiner selection errors in repetition all obeyed syntactic rules. For example she repeated 'some brass' as 'the brass'. We conclude therefore that MH has a deficit in production of determiners, but that she has implicit knowledge of lexical syntax for nouns, which is shown by her positive response to determiner cues, and in her determiner selection errors.

Summary

MH has agrammatic non-fluent aphasia with severe anomia. She has impaired semantic processing. Errors in picture naming, repetition and reading aloud involve mainly lexical selection errors. Her lexical syntactic processing was impaired. There was evidence of a mild phonological impairment. We propose that MH's word-finding deficit arises from three sources: mildly impaired semantics, a significant deficit at the lemma level, and mildly impaired output phonology. Although she produces determiner plus noun constructions in connected speech this is impaired, with frequent omissions of determiners, and a limited range of determiners, but she has implicit knowledge of lexical syntactic rules.

We then compared MH's profile to the participants described in Herbert et al. (2012). Those whose picture naming and connected speech improved after the therapy met two criteria. They had relatively intact output phonology, and they had some residual access to

determiners in connected speech, in that they could produce determiner plus noun combinations on some occasions. MH met both of these criteria.

The study we devised involved four stages: assessment, involving language assessment and baseline measures; lexical therapy, involving phonological cueing; noun syntax therapy, focussing on determiner and noun combinations; and finally a period of no intervention. The design is outlined in figure 2. Assessments were conducted twice before the lexical therapy, after the lexical therapy, after the noun syntax therapy, and after the no intervention period.

Figure 2 here

At each of the five assessment points a set of language tests was administered: picture naming, Cinderella narrative, a sample of conversation, and a set of untreated language control tasks. The outcome measures are described below.

Picture naming

The picture naming set consisted of 80 photographs depicting 40 count and 40 mass nouns. The sets were matched for key variables. Some items were foodstuffs, but none were animate, and none were collective or super-ordinate terms, compound nouns or plurals. Name agreement for the pictures was established (95% or greater agreement with 15 older adult controls, mean age 68).

The 80 items were presented in random order on a computer screen, with the instruction to name the picture with one word. The final response within 20 seconds was scored. Errors were classified as visual; semantic; phonological; unrelated words and non-words; and failure to respond. MH's responses at assessment 1 are shown in table 2.

Table 2 here

Connected speech

For the Cinderella narrative MH retold the story having seen pictures depicting the main events. The conversations were conducted between MH and the first author. Each conversation lasted fifteen minutes, the middle five minutes being analysed. The narrative samples and the conversations were audio-recorded and transcribed orthographically by a researcher not connected to the study. The first author then listened to the audio-tapes and checked each sample for accuracy.

For each sample we computed the following values for MH: the total number of words in the sample, the total number of nouns, the proportion of words which were nouns, the type token ratio for nouns, the determiner index, the proportion of nouns produced with a determiner and the number of determiner types. We included the total number of nouns so that we could compute proportional data.

In counting the nouns we included semantic and phonological paraphasias. Perseverations such as 'shoes shoes shoes' were treated as one noun, unless there was at least one intervening lexical item (e.g. 'shoes yes shoes'), when each production was treated as a separate noun. As MH sometimes produced the same lexical term several times, hence may have been perseverating, we asked two researchers not connected with the study to identify

perseverations in the samples. They found one agreed instance of perseveration at Assessment 1, and one researcher identified one at Assessment 2. We concluded that this was not a significant issue, and we included these items in the final count. MH tended to use lexical terms several times for emphasis, identifiable via the audio-recordings.

We included determiners, quantifiers, and numerals in the set of determiners. When MH counted from one up to the target numeral, this series was treated as one determiner. Pronominal forms involving numerals were excluded (e.g. 'two of them'). MH's repeated utterance 'this one' was also excluded. All samples were analysed by the first and second authors, and disagreements were resolved by discussion.

Perkins et al., (1999) recommended the use of proportional rather than raw data for analysing conversation data, as participants' contributions often vary considerably across conversations. Thus the total number of nouns may be fewer in one conversation than in a second, but be the same proportionally to the turns taken. We therefore also included a second proportional analysis of the conversation samples, by dividing the number of nouns produced by the number of substantive turns taken, where a substantive turn is defined as a turn containing at least one content word (see Herbert et al., 2008). This measure has shown positive gains in a previous study (Best et al., 2011).

Language control tests

Auditory sentence comprehension (CAT: Swinburn et al., 2005), non-word repetition, and digit span were used to control for any general language improvement or spontaneous change.

Intervention

After baseline testing the 80 items in the picture naming test were pseudo-randomly allocated to treated and untreated sets for the lexical therapy, giving 40 items per set, 20 mass nouns and 20 count nouns. The treated and untreated sets were matched for naming performance at baseline. As a result the treated and untreated sets for the lexical therapy included equal numbers of correctly named items. This is the same method as used in a variety of previous studies (see Hickin et al., 2002; Herbert et al., 2003; Best et al., 2011; Herbert et al., 2012).

After the lexical therapy the items were re-sorted to provide treated and untreated sets for the noun syntax therapy, using the same criteria as outlined above. Half of the items which had been treated with lexical therapy were then also treated with syntactic therapy, with the two sets matched for performance. The other half of this set was untreated in this phase. Half the items which had not been treated with lexical therapy were treated with noun syntax therapy. The other half were untreated. As a result, there were ultimately four sets. Set 1 was treated with lexical therapy only. Set 2 was treated with syntactic therapy only. Set 3 received both treatments. Set 4 received no treatment. Equal numbers of correctly and incorrectly named items at baseline prior to therapy were in each set. Equal numbers of mass and count nouns were in each set. The allocation of items to sets is shown diagrammatically in figure 3.

Figure 3 here

Lexical therapy

Each item was presented once in each session for MH to name. If she named the item within 10 seconds, the next item was then presented. If she failed to name the item, the researcher presented a phonological cue consisting of the first phoneme of the target word plus schwa. If she still failed to name the item the researcher presented increasing amounts of the phonology of the target as follows: the first two phonemes; the first three phonemes; the whole word. The order of presentation of the items varied across sessions. Each session lasted around 40 minutes. Six sessions in all were completed, one session per week.

Noun syntax therapy

A sentence frame was presented with each picture (figure 4). This consisted of a sentence written in black font size 36, followed by two spaces indicated by a red line and a blue line. The sentence was the same in all sessions for all items: 'The woman can see….'. Two determiners were used in all sessions: *some* for mass nouns and *a* for count nouns. The red line represented the determiner slot and the blue line the noun slot. MH was alerted to the presence of the slots and asked to think about two words - the determiner and the object name - throughout the therapy. The researcher pointed to the written words in the sentence frame and said them aloud. The cueing therefore included both sentence and phrase level information, but the task involved active focus on the phrase level.

The level of difficulty increased over the course of the six sessions. In the first two sessions MH was shown the correct determiner on a card, and the picture, and asked to place the determiner card in the correct position, and say the determiner and noun. In sessions three and four she selected the correct determiner from a choice of two, positioned the determiner, and said the determiner and the noun. In sessions five and six she produced determiner and noun without support. If MH was unable to select the correct determiner in sessions three and four this was done for her. If she was unable to produce the correct determiner in sessions five and six, the written card was presented. In all sessions, if MH was unable to produce the determiner and noun the researcher said these aloud for her and she attempted to repeat the two words. Each item was presented once in each session for naming. Items were presented in blocks of 10 mass or 10 count nouns. Order of items within the blocks varied across sessions. This therapy was therefore identical to that described in Herbert et al., (2012), except that a therapist delivered it in place of a computer. The number, length, and frequency of sessions was the same as for the lexical therapy.

Figure 4 here

Maintenance

After completion of the noun syntax therapy, six weeks without any intervention elapsed, after which the final set of assessments was completed.

RESULTS

Therapy effects on picture naming

Figures 5a-5d show the numbers correctly named in each set at each assessment point. The statistical analysis consists of McNemar's one-tailed tests. Baseline comparisons between Assessments 1 and 2 showed no significant difference for any of the four sets, indicating that prior to the therapy phases naming performance was stable.

Figures 5a-5d here

Analysis of the effects of *lexical therapy* was carried out by comparing scores between Assessments 1 and 3, for sets 1 and 3 (figures 5a and 5c). Lexical therapy led to significant gains in picture naming for both sets (McNemar, $p<0.03$ for both analyses). Analysis of the combined data from the two treated sets showed a significant overall effect of lexical therapy at Assessment 3 (comparing Assessment 1: McNemar $p=0.0005$).

Analysis of the effects of *noun syntax therapy* was carried out by comparing scores between Assessments 3 and 4 for sets 2 and 3 (figures 5b and 5c). Syntactic therapy led to numerical gains in picture naming for both sets but comparisons were not significant. For items in set 2 (figure 5b), the comparison approached significance (McNemar, $p=0.06$). Analysis of the combined data from the two treated sets showed a significant overall effect of noun syntax therapy at Assessment 4 (comparing Assessment 1: McNemar $p=0.03$).

To assess maintenance of lexical therapy we analysed Set 1 (figure 5a). The effects shown at Assessment 3 were maintained at both subsequent Assessments, with no significant difference between scores at Assessment 3 and Assessment 4, or between scores at Assessment 4 and Assessment 5. There was also a significant difference between Assessment 1, the higher of the two baseline scores and Assessment 5 (McNemar $p=0.04$).

To assess maintenance of noun syntax therapy we analysed Set 2 (figure 5b). Recall that this set showed numerical improvement but this was not significant. There was no significant difference between scores at Assessments 4 and 5. Comparison of Assessments 1 and 5 showed no difference (McNemar $p=0.34$). We therefore conclude that the small gains made in noun syntax therapy for this set were not maintained. Accuracy for items treated in both phases (figure 5c) was also not maintained, with the comparison between Assessment 1 and Assessment 5 failing to reach significance (McNemar $p=0.50$).

Finally there were no significant differences between any pairs of scores throughout the study for items which received no treatment, indicating a stable baseline, and no effect of therapy on production accuracy. This indicates that neither the lexical nor the syntactic therapy had an effect on untreated items.

Effects of therapy on connected speech

The data pertaining to the connected speech samples are shown in table 3. Abridged extracts from the Cinderella narratives from Assessments 3, 4, and 5 are shown in figure 6. Effects of lexical therapy are shown at Assessment 3 and effects of noun syntax therapy are shown at Assessment 4. One-tailed Poisson Trend Tests were used for all comparisons, comparing scores at Assessment 3 with scores at Assessments 1 and 2, to analyse effects of lexical

therapy, and by comparing scores at Assessment 4 with scores at Assessments 1, 2, and 3, to analyse effects of noun syntax therapy. To analyse maintenance of therapy effects we compared scores at Assessments 1, 2, and 3, with Assessment 5.

Table 3 here

Figure 6 here

Cinderella data

Lexical therapy effects
After the lexical therapy there were no significant changes for any of the measures: total number of nouns (z=0.40, p=0.345); proportion of words which were nouns (z=1.2, p=0.45); type token ratio nouns (z=-1.4, p=0.08); determiner index (z=-0.92, p=0.18); proportion of nouns produced with a determiner (z=0.52, p=0.30); number of determiner types (z=0.47, p=0.318). The determiners used in the Cinderella narrative at Assessment 3 included 'a' and numerals.

Noun syntax therapy effects
After the noun syntax therapy there were significant increases in four measures: total number of nouns (z=2.6, p=0.005); type token ratio nouns (z=2.21, p=0.013); determiner index (z=2.22, p=0.013); proportion of nouns produced with a determiner (z=3.46, p<0.001). The proportion of nouns and the number of determiner types increased, but not significantly (proportion nouns: z=1.26, p=0.10) (determiner types: z=1.12, p=0.132). Determiners produced in the Cinderella narrative at Assessment 4 consisted of 'a', numerals, possessive 'his' and demonstrative 'this'. All the determiner plus noun combinations were appropriate. The majority of noun phrases produced with a determiner at this time point involved singular count nouns, where an obligatory determiner was required.

Conversation data

Lexical therapy effects
After the lexical therapy there were no significant changes for any of the measures: total number of nouns (z=-1.23, p=0.109); proportion of nouns (z=-0.18, p=0.43); type token ratio nouns (z=0.8, p=0.212); proportion of nouns per substantive turn (z=-0.06, p=0.48); determiner index (z=-0.87, p=0.19); proportion of nouns produced with a determiner (z=0.71, p=0.24); number of determiner types (z=0.23, p=0.408). Determiners produced in the conversation at Assessment 3 consisted of 'a' and numerals.

Noun syntax therapy effects
After the noun syntax therapy there were significant increases in three of the measures: proportion of nouns per substantive turn (z=2.53, p=0.006); determiner index (z=1.62, p=0.05); and proportion of nouns produced with a determiner (z=3.96, p<0.001). There was no difference in total number of nouns (z= 0.52, p=0.301), proportion of nouns (z=0.90, p=0.18); the type token ratio nouns (z=0.21, p=0.417), or the number of determiner types (z=0.65, p=0.259). Determiners produced at Assessment 4 consisted of 'a', 'the', 'an' and numerals. All the determiner plus noun combinations were appropriate. Most of them involved obligatory determiners (e.g. 'an arm in a sling', 'going to the doctor's').

Maintenance of therapy effects

Cinderella
Increased production was maintained for three of the parameters at the final assessment: total number of nouns ($z=2.35$, $p=0.009$); proportion of nouns ($z=2.18$, $p=0.02$); and the proportion of nouns produced with a determiner ($z=2.24$, $p=0.012$). None of the other measures were significantly different from scores at Assessments 1,2 and 3.

Conversation
Increased production was maintained for two of the parameters: the proportion of nouns produced per substantive turn ($z=5.51$, $p<0.001$), and the proportion of nouns produced with a determiner ($z=2.83$, $p=0.002$).

Summary of connected speech data

Lexical therapy had no effect on noun and determiner phrase integrity, as measured by determiner index. It also did not affect the number of nouns produced in total, the proportion of words which were nouns, the syntactic context in which they were produced, or the number or range of determiners produced. This is in line with the predictions made at the start of the study.

In contrast, and as predicted, noun syntax therapy led to changes in all the measures examined, apart from two variables in Cinderella (the proportion of nouns and the number of determiner types), and two variables in conversation (the raw score for total nouns and the type token ratio for nouns). The proportion of nouns did increase immediately after the noun syntax therapy and a significant increase from before therapy was evident after follow-up at the final assessment. There was greater integrity of noun and determiner phrases, as measured by determiner index, in both Cinderella and conversation. In addition there were significantly more nouns in the Cinderella narrative, and significantly more nouns per substantive turn in the conversation data. The increase in nouns was largely due to increased numbers of determiner plus noun combinations, and not to more nouns in isolation. Of note is that none of the nouns produced in the narratives or the conversations appeared in the therapy sets.

In terms of determiner production, MH produced predominantly ‘a’ and numerals in her noun phrases. This pattern of production maintained throughout the study with minor changes. After the noun syntax therapy there was a small change to the range of determiners, with ‘this’ and ‘his’ also being produced in Cinderella, and ‘the’ and ‘an’ being produced in conversation.

Although there was deterioration in some scores at Assessment 5 (follow-up), there was still some evidence that the effects of noun syntax therapy on noun production and on noun plus determiner production were maintained after the period of no intervention, with number or proportion of nouns and proportion of nouns produced with a determiner maintaining their scores.

Language control data

Table 4 here

The results for the language control tasks are shown in table 4. There were no significant changes for any of the tests, and there were no ceiling effects.

DISCUSSION

In this single case study we add to the evidence base of effective therapies for word finding difficulties in aphasia. We provide further details of the specific effects of a novel noun syntax therapy, showing its impact on lexical retrieval in picture naming, narrative and conversation. By isolating the effects of the noun syntax therapy we are able to make more confident claims about the mechanisms of the therapy.

Previous studies have found item-specific effects after lexical therapy (e.g. Miceli et al., 1996; Hickin et al., 2002). We therefore predicted that the lexical therapy would lead only to improved naming of treated words, and this was indeed the finding. Treated words improved, but no other effects were found. These findings are in line with previous research into this type of therapy and with the theoretical accounts explaining the mechanism of this form of therapy (Miceli et al., 1996; Howard et al., 2006). The data support the contention that for some people with aphasia successful carryover to narrative and to conversation requires intervention beyond single words.

For the noun syntax therapy we predicted improved picture naming of treated and untreated words, and more nouns and determiner plus noun constructions in connected speech. The predictions relating to noun syntax therapy were on the whole upheld. Nouns treated in therapy improved (when the analysis included the whole set of 40 words), although this was not as marked an improvement as that found for lexical therapy. There were more nouns, more variety of nouns, a higher determiner index, and more determiner plus noun phrases in the Cinderella narrative, and the proportion of nouns increased non-significantly, as did the range of determiners used. The total nouns, the proportion of nouns, and the variety of nouns did not improve in conversation, but the proportion of nouns in each substantive turn improved, and the determiner index and proportion of determiner plus noun combinations increased. The data indicate that MH's access to determiner plus noun combinations improved as a result of the noun syntax therapy, as it was only after this therapy that a change to the syntactic structure of her noun phrases was identified. The increase in the number of nouns appears to relate to the increase in determiner plus noun constructions.

There was however no increase in picture naming of untreated sets of words. We did not find effects on untreated words in the previous study (Herbert et al., 2012), and we argued there that this might be due to the naming task itself, which did not incorporate determiner production. Future testing could include a test of determiner plus noun phrase production, in place of bare nouns.

The two interventions differed in the degree to which naming of treated nouns improved. Gains after lexical therapy were 23%, whereas gains after noun syntax therapy were 18%. This may reflect a larger effect of lexical therapy, which arguably targeted only access to phonological representations. Or it may be an artefact of the study design, in which the lexical therapy had the advantage of working solely on untreated words, whereas half of the treatment items for the noun syntax therapy had already received intervention hence may have reached ceiling. In addition these words had been assessed more often. Both prior treatment (e.g. Herbert et al., 2003) and amount of assessment (e.g. Nickels, 2002) are known to improve subsequent noun naming. A future study could compare two orders of administration of the therapies, or compare two groups of participants in a randomised controlled trial.

The mechanisms of therapy

We propose that there are two mechanisms operating in the noun syntax therapy. The first leads to better picture naming of items treated in therapy, and has been explained in terms of spoken word production models incorporating lexical semantic and phonological levels of representation (e.g. Caramazza, 1997) or in terms of models incorporating a lemma level (Howard et al., 2006). The therapy raises the resting level of activation of a word's nodes at two adjacent levels - lexical semantic or lemma, and phonological - and strengthens the links between nodes. As a result of this increased efficiency of operation of the system, treated words are produced more readily after repeated attempts at naming. This mechanism underlies the lexical therapy and the lexical component of the noun syntax therapy.

The second mechanism in the noun syntax therapy concerns lexical syntax as incorporated into theories such as Dell et al. (1997) and Levelt et al. (1999). As noted previously, the body of research into lexical syntactic priming finds, on the whole, that lexical syntax is only activated when it is explicitly required in production (e.g. Schriefers, 1993). In a similar vein, in relation to syntax more generally, Vigliocco et al. (2011) concluded from their review of the literature on noun and verb processing that syntactic and lexical processes work independently, unless obliged to operate in tandem by the specific task undertaken. Lexical therapies typically involve tasks which do not require lexical syntactic operations, so, by this account, lexical syntax is not activated, and should not improve.

In contrast, the noun syntax therapy targets nouns in phrasal and sentential contexts. This involves activation of noun phrase syntax information, consequently, in connected speech, this syntax is produced more readily, with subsequent effects on noun production. Noun production increases as there is syntactic priming of nouns, created by the production of 'determiner plus __' structures into which the noun can be slotted.

A final possibility to consider as a therapy mechanism is that MH adopted a conscious strategy of self-cueing through production of the determiner. This cannot be ruled out, but against this hypothesis is the fact that MH showed little explicit knowledge of determiners in all testing, having only implicit knowledge, which was shown in her response to determiner cues and her repetition errors. Other participants with aphasia might be able to develop determiner cueing as a self-priming strategy but we are not convinced that was the case here.

Maintenance of therapy effects

The effects of the two therapies on picture naming differed, with maintenance found only in the set treated with lexical therapy. This priming of phonological forms is positive, as long as these words are useful to the participant and are accessible in everyday conversation. The noun syntax sets did not maintain their smaller improvement. This may be because the additional focus on determiner selection and production led to a splitting of limited processing resources between noun production and determiners. It may be that more therapy or more intensive therapy is required in order for both determiner phrases and specific phonological output to improve.

The effects on connected speech were maintained in terms of number of nouns overall (total nouns and proportion of nouns for narrative, and nouns per substantive turn for conversation), and in terms of the proportion of nouns produced in a determiner plus noun structure in narrative and conversation. These are positive and functionally significant findings. It is more

important to the person with aphasia that they produce more nouns in connected speech, in particular in conversation, than more picture names.

Study design

The data presented here pertain to one individual, who, it could be argued, presented with an unusual pattern of processing of noun syntax. Specifically, MH showed an advantage for count nouns over mass nouns, a difference which disappeared when noun production was cued with syntax (Herbert & Best, 2010). We do not know how other people with similar aphasic symptoms would react to these cues, but it is feasible that MH presents as an unusual case. On the other hand, she presents with fairly typical agrammatic production, so it is feasible that other people with this profile will also benefit from the therapy. In the previous related study (Herbert et al., 2012) participant MJ had a similar profile to MH, and he also showed effects on naming and connected speech. The effects of the therapy on a range of people with aphasia need to be examined further, before conclusions regarding its efficacy and the mechanism of therapy can be drawn.

The study analysed the effects of the two therapies consecutively. There is a possibility therefore that the effects on connected speech resulted from the cumulative impact of the two therapies, or from a delayed effect of the lexical therapy. Future work could address this using alternative designs including randomised groups.

Conclusion

Most people with aphasia have word-finding difficulties. They also often present with a concomitant impairment in production of syntax, affecting sentence production, but also causing difficulties at phrase level (Herbert et al., 2012). Lexical therapy can improve lexical retrieval of nouns in isolation, and as such presents an effective form of therapy. Evidence from a range of sources suggests that isolated noun production is unlikely to engage lexical syntax however, so, for speakers with a deficit in noun syntax, this form of therapy may not be able to influence noun retrieval in connected speech. The data reported here build on the evidence from Herbert et al. (2012) in isolating the effects of determiner and noun production in connected speech to the noun syntax therapy, and extending those findings to conversation. We argue here that improved access to noun syntax, specifically to determiner plus noun structures, enables more efficient noun phrase retrieval in connected speech. Future research needs to trial the noun syntax therapy described here with a greater range of types of anomia and degrees of deficit in lexical syntax, in alternative experimental designs, in order to provide further evidence concerning the impact of this form of therapy.

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Table 1: Language test results

	N=	Normal controls range	Score	Proportion correct
Spoken word production				
Picture naming test CAT[a]	24		13	0.54
Semantic errors			11	0.46
Semantic processing				
Spoken word to picture matching (CAT[a])	30	25-30	28	0.93
Written word to picture matching (CAT[a])	30	27-30	25	0.83
Pyramids and Palm Trees[b] (three pictures)	52	49-52	48	0.92
Comprehension				
Auditory sentence comprehension (CAT[a])	32	26-32	16	0.50
Written sentence comprehension (CAT[a])	32	24-32	16	0.50
Phonological output				
Repetition words	182	-	175	0.96
Repetition non words	26	-	15	0.58
Read aloud words	182	-	98	0.54
Read aloud non-words	26	-	0	0.00
Phonological STM				
Digit span A1		5-9	2.5	
Nonverbal				
Line bisection	-	-	NAD	-
BORB[c] Object decision B: Easy	32	28-32	24	0.75
BORB[c] Object decision B: Hard	32	22-30	24	0.75
Noun syntax				
Determiner index (Cinderella narrative)[d]	-	-	0.56	

NAD = nothing abnormal detected
[a]CAT Comprehensive Aphasia Test (Swinburn, Porter & Howard, 2005)
[b]Pyramids and Palm Trees (Howard & Patterson, 1992)
[c]BORB Birmingham Object Recognition Battery (Riddoch & Humphreys, 1992)
[d]Mean of two pre-therapy assessments
All other tests available from the authors

Table 2: Picture naming responses at Assessment 1

n=80	Raw score	Proportion correct
Correct	30	0.38
Visual errors	10	0.12
Semantic errors	24	0.30
Phonological errors	1	0.01
Unrelated errors	3	0.04
No response	12	0.15

Table 3. Determiner and noun production in narrative and conversation

Assessment point:	1	2	3	4	5
Total words in Cinderella sample	172	294	206	234	179
Total words in conversation sample	311	189	212	201	218
Cinderella data					
Total number of nouns	16	24	19	**37****	**35****
Proportion words = nouns	0.09	0.08	0.09	0.16	**0.20****
Type token ratio nouns	0.50	0.54	0.36	**0.75***	0.66
Determiner index	0.56	0.57	0.46	**0.82***	0.65
Proportion nouns produced with a determiner	0.33	0.41	0.38	**0.69*****	**0.56***
Number of determiner types	4	5	6	8	8
Conversation data					
Total number of nouns	15	6	9	17	15
Proportion words = nouns	0.05	0.03	0.04	0.08	0.07
Type token ratio nouns	0.47	0.66	0.56	0.53	0.47
Proportion of nouns per substantive turn	0.44	0.29	0.43	**0.65****	**1.00*****
Determiner index	0.60	0.67	0.50	**0.89***	0.67
Proportion nouns produced with a determiner	0.43	0.33	0.50	**0.80*****	**0.67****
Number of determiner types	3	2	2	5	4

Note: Significance values for Poisson Trend test: *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$. Figures in bold denote significant changes.

Table 4. Untreated language control data

	A1	A2	A3	A4	A5
Auditory sentence comprehension[a] (n=32)	16	20	13	20	15
Non word repetition (n=26)	13	15	13	14	13
Digit span	2.5	2.1	2.1	2.1	2.3

A1 to A5 refer to assessments one to five. [a]CAT Comprehensive Aphasia Test (Swinburn, Porter & Howard, 2005). Non-word repetition, David Howard, personal communication. Digit span, immediate serial recall using staircase method to obtain span.

this one . and there . and this one as well . and pots and pans and er this one as well . a dog . and this one as well . this one . and this one as well . and this one . broom . and er cauldron and er . this one as well . keys . but this one and this one

. = micropause

Figure 1. Cinderella narrative sample at Assessment 1

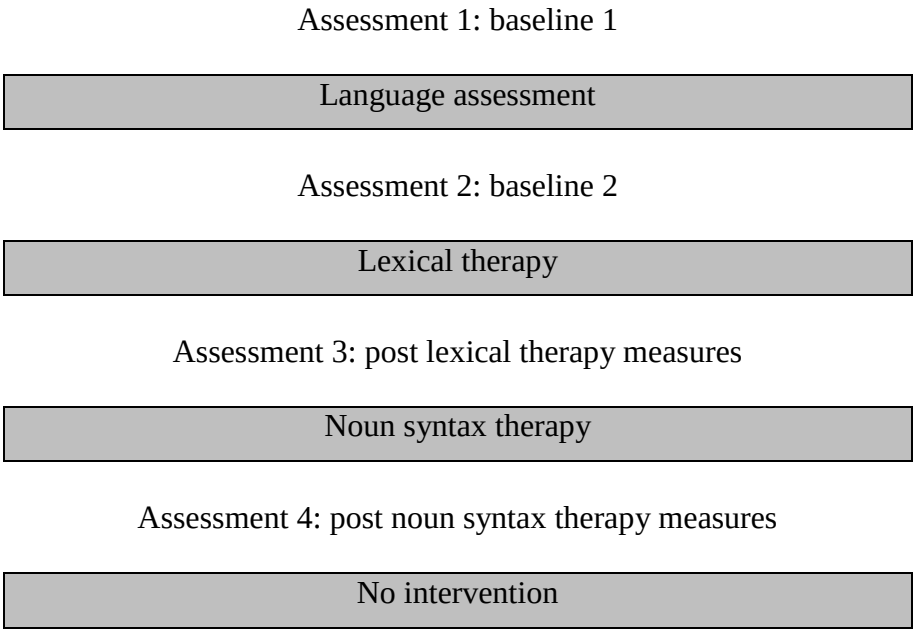


Figure 2. Design of the study

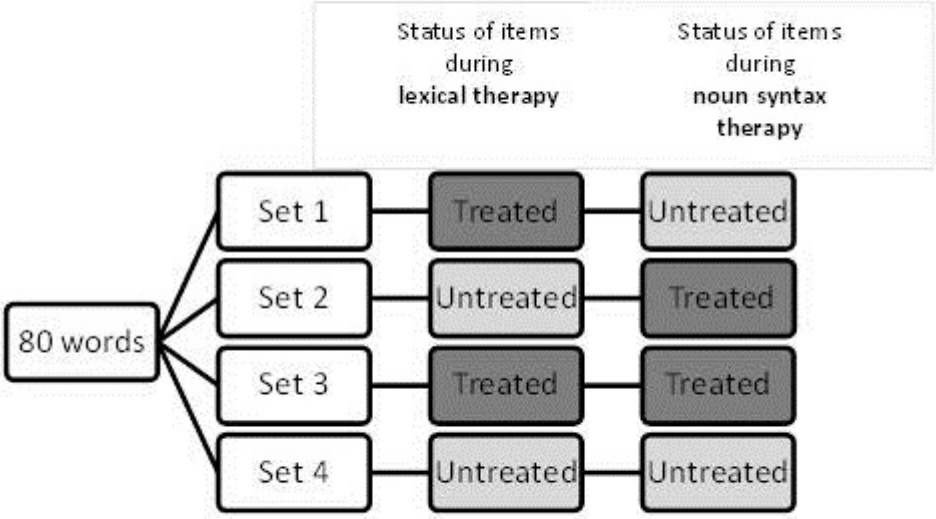


Figure 3. Allocation of items to sets for therapy

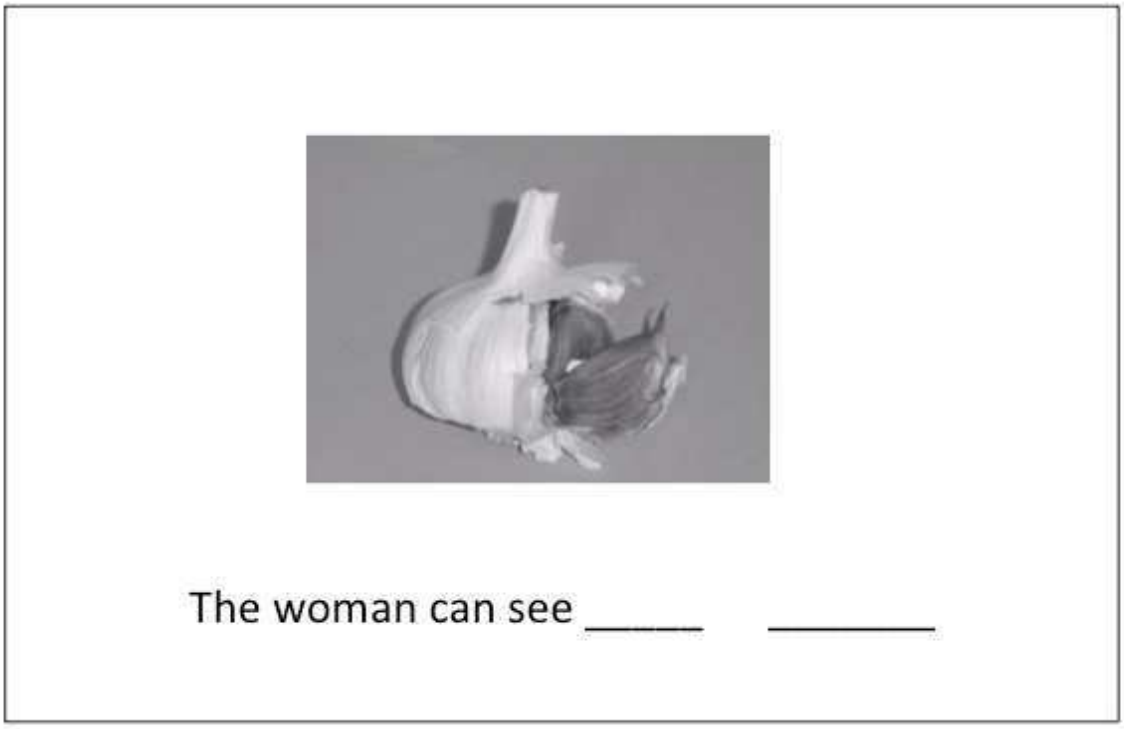


Figure 4. Noun syntax therapy: example of therapy task

Figure 5a: Set 1 Lexical therapy only

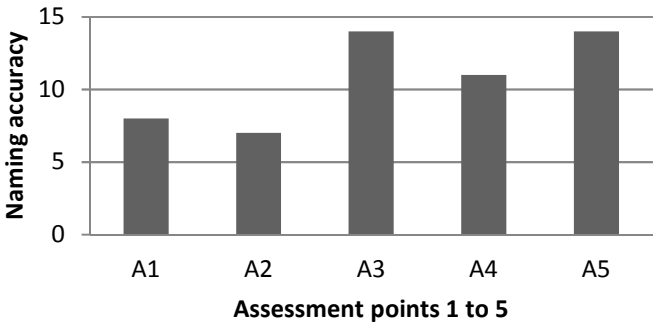


Figure 5b: Set 2 Noun syntax therapy only

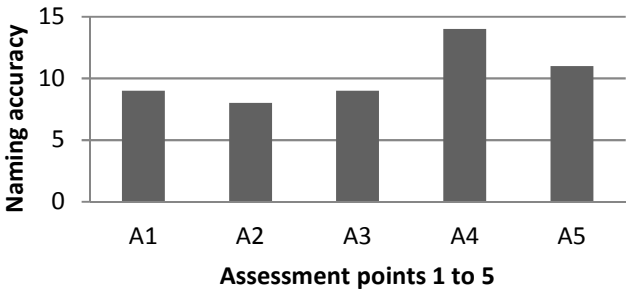


Figure 5c: Set 3 Lexical therapy then noun syntax therapy

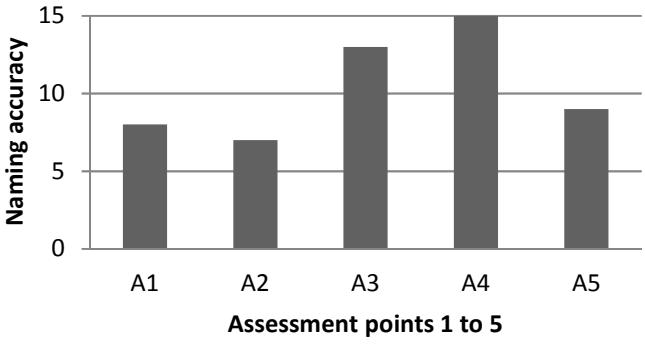
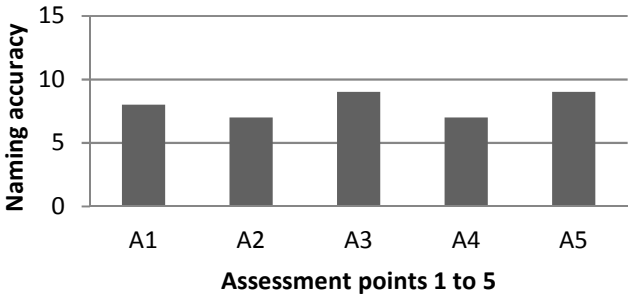


Figure 5d: Set 4 No therapy



Figures 5a-5d. Naming accuracy for Sets 1-4.

Assessment 1 – baseline
this one . and there . and this one as well . and pots and pans and er this one as well . a dog . and this one as well . this one . and this one as well . and this one . broom . and er cauldron and er . this one as well . keys . but this one and this one

Assessment 3 – after lexical therapy
/b/ ballerina yes it does and then one two of them this one as well yes it does er ballerina and er . coach there as well yes . one two women and er this one one two three four yes it does er this one two of them again and and then this one and then horse this one as well . a coach and horse and er this one a coach and er this one one two three four five six

Assessment 4 – after noun syntax therapy
what's two women there /t/ er staircase and a shoe there and a . this one as well but his shoes and he's er this one . one two at er . shoes and we . this one as well . one two shoes and er slippers and one there he's one two three four five er slippers and er this one . it's a horse on a . this stable and er this one he's a . this one

Assessment 5 – after no intervention
a clock . cutlery there . cauldron there . he's a this one. but er a brush and then he's down it's it's /r/ risen isn't it one two three four five two /g/ girls and er this one er this one this one . ooh one two three . it's er this one . but er this one . broom er this one . one two and then the girl is er . magic is er . this one

Figure 6. Cinderella narrative sample at Assessments 1,3, 4 and 5